BIOLOGY

Paper 9700/11
Multiple Choice

Question Number	*Key*	*Question Number*	*Key*
1	**B**	21	**D**
2	**A**	22	**C**
3	**D**	23	**D**
4	**A**	24	**C**
5	**B**	25	**B**
6	**B**	26	**A**
7	**C**	27	**B**
8	**D**	28	**D**
9	**A**	29	**A**
10	**C**	30	**B**
11	**D**	31	**C**
12	**A**	32	**C**
13	**B**	33	**D**
14	**B**	34	**D**
15	**D**	35	**A**
16	**A**	36	**A**
17	**C**	37	**C**
18	**A**	38	**B**
19	**C**	39	**A**
20	**D**	40	**A**

General comments

There was a good spread of scores. One question was answered correctly by more than 75% of candidates, **Question 38**. **Questions 5, 7, 11, 32, 33 and 34** proved to be more difficult, with 30% or fewer candidates answering them correctly.

Comments on specific questions

Question 1

More than half of all candidates answered this correctly, although a significant number thought that structure **A** was correct.

Question 2

Almost three quarters of the more able candidates and over a quarter of the less able candidates answered this correctly.

Question 3

More than half of the more able candidates answered this correctly. The majority of less able candidates did not realise that prokaryotic cells do not contain cellulose.

Question 5

The effects of various factors on the resolution of a light microscope were understood by less than a quarter of all candidates.

Question 6

Less than half of less able candidates were able to calculate the magnification, whilst the majority of more able candidates could.

Question 7

The majority of candidates did not realise that an answer including 'no colour change' and or 'changed colour' does not indicate that a correct test has been carried out.

Question 8

Less than a third of candidates knew the correct details for β-glucose, collagen, haemoglobin and sucrose.

Question 9

Whilst over half of the more able candidates knew that disulphide bonds were covalent, only a few less able candidates knew this.

Question 11

Whilst the majority of candidates answered this question correctly, many incorrectly thought that triglycerides are formed from three fatty acids and glycogen, rather than glycerol and three fatty acids.

Question 15

Less able candidates continue to have difficulty in understanding the roles of the components of the cell surface membrane.

Question 22

Whilst over half of the more able candidates knew how the sugar phosphate backbone was joined, only a few less able candidates knew this.

Question 27

Whilst many candidates answered this correctly, the Bohr effect is poorly understood by less able candidates.

Question 29

Over half of the more able candidates could use the information provided and link this to their knowledge of the cardiac cycle.

Question 30

Over half of all candidates did not know that ions cannot diffuse through the phospholipid bilayer.

Question 32

The binding of oxygen, carbon monoxide and carbon dioxide to haemoglobin is poorly understood by many candidates.

Question 33

Over half of all candidates incorrectly selected **C**. This cannot be supported, since the graph showing the number of deaths was in all men, not smokers.

Question 34

The majority of candidates found this question challenging.

Question 35

This was correctly answered by nearly all of the more able candidates.

Question 37

Over half of less able candidates do not understand ways in which TB is transmitted.

Question 40

Less than half of all candidates were able to calculate the answer of 1.3%.

BIOLOGY

Paper 9700/12
Multiple Choice

Question Number	*Key*	*Question Number*	*Key*
1	**A**	21	**B**
2	**A**	22	**C**
3	**B**	23	**A**
4	**C**	24	**A**
5	**B**	25	**B**
6	**C**	26	**D**
7	**B**	27	**C**
8	**B**	28	**B**
9	**B**	29	**D**
10	**C**	30	**B**
11	**D**	31	**B**
12	**C**	32	**C**
13	**C**	33	**D**
14	**A**	34	**C**
15	**D**	35	**A**
16	**A**	36	**B**
17	**D**	37	**C**
18	**A**	38	**C**
19	**D**	39	**C**
20	**C**	40	**D**

General comments

There was a very good spread of scores. Eight questions were answered correctly by more than 75% of candidates, **Questions 3, 6, 13, 16, 17, 25, 29 and 32. Questions 9, 10, 15 and 33** proved to be more difficult, with 40% or fewer candidates answering them correctly.

Comments on specific questions

Question 1

More than half of all candidates answered this correctly, although a significant number thought that **D** was correct.

Question 2

Almost a third of less able candidates incorrectly thought that prokaryotic cells contain endoplasmic reticulum.

Question 6

Less than half of weaker candidates were able to calculate the diameter, whilst the majority of more able candidates could do so.

Question 7

The majority of candidates realised that heating with hydrochloric acid breaks glycosidic bonds. Candidates who had practical experience of carrying out the test for non-reducing sugars using Benedict's solution would have knowledge of this.

Question 10

Just over a third of all candidates realised that a changed amino acid, could change all except the quaternary level of protein structure.

Question 11

The majority of less able candidates have difficulty understanding the structure of polysaccharides.

Question 14

Almost half of all candidates correctly processed the information provided and realised that the *x*-axis on all graphs was time.

Question 15

Over half of all candidates incorrectly thought that the fluidity of phospholipids was not important in cytokinesis.

Question 18

The concept of different water potentials remains poorly understood by less able candidates.

Question 22

Less able candidates continue to find it difficult to distinguish between the three processes of replication, transcription and translation.

Question 24

The majority of less able candidates are unclear about the uptake and transport of water. A small but significant number of candidates thought the symplast and apoplast pathways occurred within the xylem.

Question 28

The Bohr effect is poorly understood by less able candidates.

Question 33

Almost half of all candidates incorrectly used the information provided and selected **B**. Deposits of fatty material in veins would not result in heart failure.

Question 34

The majority of less able candidates found this question challenging.

Question 39

The nitrogen cycle is poorly understood by over half of less able candidates.

BIOLOGY

Paper 9700/13
Multiple Choice

Question Number	*Key*	*Question Number*	*Key*
1	**A**	21	**C**
2	**D**	22	**D**
3	**B**	23	**D**
4	**B**	24	**A**
5	**D**	25	**A**
6	**D**	26	**A**
7	**A**	27	**B**
8	**B**	28	**C**
9	**B**	29	**B**
10	**A**	30	**B**
11	**D**	31	**D**
12	**A**	32	**D**
13	**D**	33	**D**
14	**B**	34	**C**
15	**A**	35	**C**
16	**C**	36	**C**
17	**C**	37	**B**
18	**D**	38	**C**
19	**B**	39	**D**
20	**C**	40	**C**

General comments

There was a very good spread of scores. Eighteen questions were answered correctly by more than 75% of candidates, **Questions 1, 3, 4, 5, 7, 9, 10, 12, 14, 17, 19, 20, 23, 25, 27, 29, 37 and 38. Questions 26, 39 and 40** proved to be more difficult, with 40% or fewer candidates answering them correctly.

Comments on specific questions

Question 2

Almost half of all candidates were able to deduce the correct answer.

Question 6

The majority of less able candidates did not take into account the loss of water molecules when starch is formed from its monomers.

Question 8

Less than half of candidates know that glycerol does not contain C=O bonds.

Question 12

Whilst the majority answered this correctly, most of the less able candidates find it difficult to recognise the structure of α-glucose or β-glucose.

Question 28

The Bohr effect is poorly understood by less able candidates.

Question 30

Over half of all candidates could use the information provided and link this to their knowledge of the structures in the gas exchange system.

Question 32

The majority of less able candidates thought that T-helper cells are destroyed as an effect of chronic bronchitis.

Question 33

Less able candidates found this difficult and selected each option almost equally.

Question 40

Many candidates did not use all the information provided and incorrectly selected option **A**.

BIOLOGY

Paper 9700/21
AS Structured Questions

Key Messages

Candidates should allocate sufficient time to ensure that they fully understand graphs, diagrams and photographs accompanying a question, and should refer back to these when constructing a response.

Candidates should be guided by the wording of the question, for example "State the…" will require a briefer response than "Outline the …." or "Describe the…". These terms and others are clearly explained in the syllabus and should be conveyed to all the candidates.

Candidates should be encouraged to use correct scientific terminology as this will often save time and produce a concise, well-expressed response.

General comments

Many candidates had a good grasp of the syllabus learning outcomes and were able to access those part-questions assessing knowledge and understanding. The same candidates made a good attempt at those part-questions requiring Objective B skills but found these to be much more challenging. Less well-prepared candidates were able to gain partial credit on the more straightforward questions requiring knowledge of the less conceptual syllabus learning outcomes. These candidates would have benefited from developing their analytical skills and tackling questions that required them to apply knowledge in a novel context. Weaker candidates tended to gain credit on the more straightforward, shorter part-questions and left quite a number of blanks throughout the examination paper.

There was no evidence that time was short during the examination. Generally, candidates made good use of the lines provided for written responses. Responses from a number of candidates were not always easily legible.

The questions differentiated well, with most of them based on a theme that allowed learning outcomes from different sections of the syllabus to be assessed. Most candidates performed well on **Questions 1** and **4** and then found that a much wider range of skills was required to do well on **Questions 2**, **3** and **5**. The calculation required in **Question 5(c)(i)** was completed correctly by only the strongest candidates.

Comments on specific questions

Question 1

This question assessed candidates' ability to think about the link between structure and function and assessed ***Sections A*** and ***B*** of the syllabus. Most candidates were more confident in part **(a)** than in part **(b)**.

(a) Some candidates did very well and gained full credit. Stronger candidates were able to identify each organelle confidently and correctly and then proceed to provide the details of the organelle's function, for example, stating that the function of the mitochondrion was for aerobic respiration, instead of just stating 'for respiration', which was not credited. Naming the organelles required "rough endoplasmic reticulum" and "smooth endoplasmic reticulum" to be given rather than RER and SER, although if the abbreviated versions were stated with a correct function, partial credit was given. Errors such as "endoplastic" or "endoplasmatic" were not credited. Credit could only be gained if the organelle was accompanied by a correct function and some candidates left this blank, despite correctly identifying the organelle. The most common errors were to identify organelle **A** as "nucleus" and organelle **G** as "ribosome". Some candidates thought that organelle **D** was the

"Golgi body" and **F** "smooth endoplasmic reticulum", in which case partial credit was awarded as an error, carried forward. Only the strongest candidates were able to provide a correct function for the nucleolus, with the majority of candidates referring to general functions of the nucleus instead. To gain credit for the function of the Golgi body, candidates were expected to state that modification or packaging of proteins (or lipids) occurred, rather than "molecules", which was considered to be lacking detail.

(b) In order to gain full credit, both a description and an explanation were required. Stronger candidates gave very complete answers, covering most of the points and using correct scientific terminology. Others were less accurate, for example, stating, "has 1-6 branches", rather than "has a branching structure because of the α, 1-6 glycosidic bonds". Some candidates demonstrated confusion between glycogen and starch, hence providing descriptions of amylose and amylopectin, while others explained how the molecule was an energy store rather than how it was suitable for storage. A common error was to state that the molecule was inert or inactive, rather than to explain that it did not contribute to the water potential of the cell.

Question 2

This question is an example of how candidates can apply their knowledge and understanding to a new idea. ***Sections D*** and ***G*** were being assessed. Candidates were not expected to know about aquaporins, although from some responses it is evident that some candidates have acquired a wider knowledge than the demands of the AS Syllabus.

(a) (i) The best responses to this part-question considered fully **Fig. 2.1**, which showed a cell wall as well as the cell surface membrane. Stronger candidates knew that osmosis only occurs in the presence of a partially permeable membrane, and that movement across a cell wall, being fully permeable, would be an example of the diffusion of water. The majority of candidates correctly described the movement of water molecules in terms of water potential rather than water concentration. Some candidates, when considering the presence of the aquaporin, used their knowledge of the membrane proteins that are associated with facilitated diffusion to suggest mechanisms of action of the aquaporin. Although not necessary to gain full credit for the question, this was a commendable approach and credit was given for the suggestion that the aquaporin facilitated the entry of water.

(ii) Many understood that aquaporins would enable a better uptake of water into the cytoplasm and stronger candidates correctly focused on the difficulties of passing through the hydrophobic core of the bilayer, rather than just stating that it was difficult for water to pass across the phospholipid bilayer. Weaker candidates incorrectly thought that water molecules were too large to pass across the bilayer.

(b) The best responses considered both the symplastic and apoplastic pathways of water movement across the root, rather than just describing one of the pathways. Having been told that the water was in the cytoplasm, many responses only focused on the apoplastic pathway. The majority linked the pathway type to its correct description. While many mentioned the endodermis, only a few candidates stated that water would cross the cells of the cortex. Some candidates incorrectly thought that the Casparian strip was a type of cell rather than a feature of endodermal cells.

(c) (i) This was an example of how many candidates did not respond by giving an explanation, as requested, but gave suggestions based on possible temperature differences. Hence they missed the most obvious answer, based on their knowledge of leaf structure, that the stomata are open during the day.

(ii) Many candidates thought that "..explain how the results show…" was an instruction to "..explain the results…". This meant that instead of using the results to support the argument, these candidates wrote about features and the function of the cuticle and speculated about the differences that would occur in the mutant plants, for which no credit was given. As there were no gridlines in **Fig. 2.2**, there was flexibility in the values extracted from the graph, but it was expected that candidates would give the correct units to accompany these.

Question 3

This question discriminated well and required knowledge from ***Sections E***, ***F***, ***G*** and ***J*** of the syllabus. Stronger candidates demonstrated their skill in interpreting **Fig. 3.1** and providing responses linked to syllabus knowledge and understanding. Part **(b)** of this question was the most challenging section for candidates and was frequently left unanswered.

(a) (i) Although many candidates knew what occurred at point **K**, some were not sufficiently accurate in their response to be credited, stating that chromosomes were replicated, rather than referring to **Fig. 3.1** and stating that DNA replication was occurring. There was more confusion for weaker candidates in interpreting point **L**, with many giving accounts of anaphase, which would not have halved the mass of DNA in the cell.

(ii) A good proportion correctly surmised that three blood cells would be formed, having read in the introduction that only one of the two cells formed from mitosis would be a blood cell and also noting that, in the time shown in **Fig. 3.1**, there would be three 'rounds' of cell division. Some candidates correctly noted the three rounds of cell division but gave a value that suggested that they doubled numbers each time to arrive at an incorrect value of eight cells.

(iii) This was correctly answered by many candidates. Weaker candidates equated the decrease in DNA with a halving of the number of chromosomes.

(b) A minority of candidates understood that they should describe how a red cell develops from the cell formed as a result of mitosis of a stem cell. Of these, a few realised that the nucleus and other organelles would be lost, or that haemoglobin would be synthesised, so could gain partial credit. Many simply described the features of a red blood cell, which was not required. Others equated the synthesis of a haemoglobin molecule to the production of a red blood cell. Most of the completed responses went down an incorrect route and described in detail the stages of mitosis.

(c) Good responses identified correctly the cell types of the immune system that would divide by mitosis during an immune response. In gaining full credit these responses then continued with an outline description of clonal selection and expansion, confirming knowledge of this section of the syllabus. Some candidates were not able to distinguish between B-lymphocytes and T-lymphocytes, incorrectly linking mitosis to T-lymphocytes to large numbers of antibody-secreting cells. Others thought that antibodies were cells that were produced in high concentrations as a result of mitosis.

(d) Candidates were not expected to know the different types of T-lymphocytes, but were expected to understand that different types of T-lymphocytes had different roles. Hence it was not acceptable for a candidate to amalgamate the roles of T-helper cells with T-cytotoxic cells. The stronger candidates set out their responses by naming the different T-cell types and describing accurately and concisely their mode of action. A few of these candidates went beyond syllabus requirements. Some excellent accounts were given, demonstrating a very good grasp of the immune response and the interactions that occur between T-lymphocytes, B-lymphocytes and macrophages (phagocytes). At the other extreme, some candidates did not always demonstrate a clear understanding of the terminology, such as the difference between: B-lymphocytes and T-lymphocytes; antigens, which provoke an immune response, and pathogens, which cause disease; an infected body cell and a phagocytic cell displaying antigens following phagocytosis.

Question 4

This question, which assessed ***Section K***, proved to be a very accessible question for most candidates and a number gained full credit.

(a) The majority of candidates responded correctly by naming the trophic levels of the organisms, rather than stating "first trophic level", "third trophic level" and "fourth trophic level".

(b) Almost all candidates gained credit for part **(b)**. Some candidates approached this question by considering both the loss of energy that occurs in food webs as well as the feeding styles of the polar bear and ringed seal. These restricted their responses to using only the information shown in **Fig. 4.1** and were able to gain full credit. Most candidates responded from only one of the two angles and gained partial credit. The most popular correct explanations given by candidates showed an understanding that polar bears had a limited food supply as they only fed on the ringed

seal, which had considerable competition for its food. Fewer tackled the question from an energy loss and transfer viewpoint, but these candidates generally did well. Weaker candidates lost their focus and wrote about the Arctic cod or introduced ideas that were outside the information provided in **Fig. 4.1.**

(c) Although many candidates did very well in part **(c)**, the quality of response varied considerably. Some candidates had thought carefully about the entire food web and gave valid suggestions of consequences for organisms at higher and lower trophic levels. This was more than sufficient to gain full credit. Others concentrated on the possible fate of the animals feeding on the Arctic cod. Weaker responses made general statements such as "all the organisms will die" or used most of the lines provided to explain that overfishing meant that the numbers of the Arctic cod would decrease.

Question 5

Stronger candidates made a very good start to **Question 5**, which assessed ***Sections G*** and ***H*** of the syllabus, but almost all candidates, found part **(c)** to be extremely challenging. Very few candidates gave sufficiently detailed answers to gain full credit in part **(e)**. Parts **(d)** and **(e)** were frequently left unanswered.

(a) There were two parts to this question and generally, where the explanation of the first term was given correctly, the second term was also well explained, indicating good knowledge of the learning outcome. Some candidates made attempts at explanations which suggested that they had not learned what the terms meant; of these a proportion gained some credit for an acceptable, but by no means a high quality, response. Hence there were a variety of guessed responses such as "blood cannot escape" or "there is an oxygenated half and a deoxygenated half".

(b) Knowledge of the structure of the heart was sound and all but the weakest candidates did very well on part **(b)**. Some candidates ignored the instruction to use label lines and wrote on the diagram.

(c) (i) Very few candidates were successful in calculating correctly the heart rate using **Fig. 5.2**. . Despite being a relatively straightforward calculation, it was evident that many candidates did not have the confidence to digest the information provided and study **Fig. 5.2** in order to proceed.

(ii) Most candidates found this extremely challenging and there were many that made no attempt at a calculation. The few candidates who did provide the correct answer also included correct units as "beats per minute", although other units of time would also have been accepted. Incorrect attempts at the question took many forms; some candidates did not multiply by 60, while others divided the time, 8 seconds, by the number of beats, 10. Partial credit was awarded where it was clear that candidates had counted 10 beats and knew that the time taken for these was 8 seconds. A sizeable minority took pressure readings from the graph and gave values in kPa.

(d) (i) Some candidates incorrectly named the *type* of blood vessel rather than name of the blood vessels shown in **Fig. 5.3** and so "arteries" was the most frequent incorrect answer, followed by "veins" and then by "capillaries". About a third of candidates gave the correct response.

(ii) Many candidates were able to give a valid suggestion to gain credit. Others did not give an effect but gave a feature of the narrowing, which was not required.

(e) Candidates were asked to suggest ways to treat the condition shown in **Fig. 5.3** but the majority suggested ways to prevent the condition or to prevent a worsening of the condition. These suggestions of lifestyle changes were not credited. Most of the candidates who had interpreted the question correctly did not give a sufficiently detailed or accurate response, suggesting a bypass, with no further qualification, or by suggesting that a device could be used to remove the blockage.

BIOLOGY

Paper 9700/22
AS Structured Questions

Key Messages

Candidates should allocate sufficient time to ensure that they fully understand graphs, diagrams and photographs accompanying a question, and should refer back to these when constructing a response.

Candidates should be guided by the wording of the question, for example "State the…" will require a briefer response than "Outline the …." or "Describe the…". These terms and others are clearly explained in the syllabus and should be conveyed to all the candidates.

Candidates should be encouraged to use correct scientific terminology as this will often save time and produce a concise, well-expressed response.

General comments

There were many candidates who performed extremely well on this examination paper. Questions requiring Objective B skills, including application of knowledge, were well considered and responses were expressed concisely and fluently. Questions based directly on knowledge and understanding of learning outcomes were answered with confidence and good use of scientific terminology by an even wider group of candidates. Weaker, well-prepared candidates were able to access sections for each question in the examination to achieve a good outcome. Some candidates were not well-prepared for the exam, often displaying a lack of understanding of the requirements of the question or producing responses that were too short to gain full credit.

All questions differentiated well, especially **Questions 3**, **4** and **5**. **Question 1** was generally the most accessible, although well-prepared candidates of all abilities were often able to perform very well on **Questions 2** and **4**. All sections of **Question 5** required two or more stages of thought and although most candidates gave full responses, only stronger candidates demonstrated a full understanding of what was required in order to gain full credit. **Questions 1** to **5** were based on a theme that allowed learning outcomes from different sections of the syllabus to be assessed. In addition to **Question 5**, part-questions that were challenging for candidates as they required independent thought or use of knowledge from different strands of the syllabus, were **3(a)(iii)**, **3(b)**, **4(c)(i)**, and **6(c).**

Generally, candidates made good use of the lines provided for written responses and the space provided to draw the diagram for **Question 2**. The exception to this was in **5(d)**, where some candidates used all the lines and blank spaces elsewhere as they described results, which was not required, in addition to giving an explanation. **Question 6(c)** was frequently left blank: in most of these cases, the candidates had given full responses for previous questions and did not give any indication of being rushed for time, so it is likely that part **(c)** proved to be difficult for these candidates rather than having run out of time.

Comments on specific questions

Question 1

This question assessed knowledge and understanding of ***Sections A*** and ***B***, and included a calculation to obtain a magnification. Most candidates knew the correct formula to use, but only some used the correct measurement.

(a) Most candidates noted the emboldened "same magnification" in the question and, although many wrote about the electron micrograph, rather than an electron microscope, they were awarded credit where the link between more detail and higher resolution was established. Stronger candidates

were able to gain additional credit for correct further detail, usually by qualifying their understanding of resolution, noting the shorter wavelength of electrons compared to light, or by providing the limits of resolution for the two microscope types. A small proportion of candidates answered incorrectly in terms of differences in magnification possible.

(b) For those candidates who had carefully read the question, and who had noted the instruction to "describe", part **(b)** was a relatively straightforward question and full credit was gained. The most common responses were to note the additional detail of the mitochondria and chloroplast and to provide some description about the different types of endoplasmic reticulum. Candidates who knew the additional features that would be observed but who just provided a list, were penalised once for this error before credit could be gained. A similar approach was taken for candidates who named correctly the feature but continued to give a function. As candidates were asked to consider **Fig. 1.1**, responses that referred to details visible under very much higher magnifications, such as the molecular components of the cell surface membrane, were not acceptable. However, reference to the ribosome being composed of a small and a large subunit, for example, was allowed as candidates were not expected to know the actual dimensions of the cell structure. "Cell membrane" was not accepted for "cell surface membrane" or "plasma membrane".

(c) The calculation required knowledge of a syllabus learning outcome defining magnification. Most candidates did show their working and if an incorrect answer was given, they were able to gain partial credit if there was evidence that the correct formula had been used and a measurement had been divided by 5 μm. Only about half of candidates realised that if the actual length of the chloroplast labelled in **Fig. 1.1** was provided, then they should measure the image length of the same chloroplast, rather than the length of the cell, in order to have a valid measurement to use in the formula for magnification.

(d) (i) Although many candidates gave sufficient information to gain full credit, the best responses used full scientific terminology, such as "α, 1-6 glycosidic bonds" rather than "1-6 bonds". Almost all understood the branching nature of amylopectin but common errors were to describe the spiral or helical structure of amylose as an alpha-helix or to state that amylopectin had only α, 1-6 glycosidic bonds. Very few candidates gave amylose features when describing amylopectin or vice versa.

(ii) The most common correct response was to acknowledge that magnesium was an important component of chlorophyll. There were numerous responses that could not be credited as the candidate had the correct idea but gave "chloroplast" instead of "chlorophyll" or was too vague and just noted that magnesium was important for photosynthesis.

Question 2

This question, assessing aspects of ***Section D***, gave candidates an opportunity to display, in diagrammatic form, their knowledge of the structure of cell surface membranes.

(a) (i) There were some superb diagrams of a section through the cell surface membrane and clearly some candidates take pride in producing diagrams that are neatly drawn, in the correct proportions and fully labelled. Almost all candidates had the correct idea of a phospholipid bilayer and many of these represented phospholipids correctly with two "tails" and in the correct orientation. Others drew the tail section as a single box or with three or more tails, and a number left a very large gap between the two layers. Full credit could only be gained if the diagram was correctly and fully labelled. The "glycoprotein" and "glycolipid" labels could only be awarded full credit if the molecules were shown projecting from the outer, or exterior, surface of the membrane. Knowledge of the arrangement and "shape" of cholesterol molecules was not necessary to gain full credit. Although stronger candidates did well on this point, the majority drew cholesterol molecules as if they were large protein molecules and many others aligned them only with the phosphate heads of the phospholipids. A number of candidates drew proteins only partially embedded in the membrane but labelled them as channel, carrier or transport proteins. Simple errors such as these could have been avoided with some more careful thought about mechanisms of transport across membranes.

(ii) There were many good responses given for this question. Some Centres appeared to have discussed the ideas of Singer and Nicolson when naming the model and some individual candidates seemed to have good background knowledge of this topic. However, as this was a "suggest" question, a range of responses were credited. Some candidates did not answer the question and wrote about factors influencing the fluidity of the membrane, while a good proportion

of weaker candidates thought that "fluid mosaic" referred to the movement of molecules and ions across the membrane.

Question 3

This question assessed ***Section B*** *and* ***Section K*** of the syllabus and discriminated well. All parts of the question were very accessible, although some candidates answered without sufficient thought being given to the standard of response required to gain full credit.

(a) (i) A good proportion of candidates gained full credit for this question. All information had been provided in the text with regards to the direction of energy flow between the consumer organism groups. Some candidates put in only these arrow heads and so did not show the direction of energy flow between the phytoplankton and their grazers. Others did not place an arrow head between the krill and herring. There were many who showed the arrow head towards krill despite being told that herring feed on krill. A few candidates did not attempt to add any arrow heads.

(ii) The best response to this question was to state "secondary consumer" or "tertiary consumer" or to give both. It was acceptable for candidates to state "third (trophic) level" or "fourth (trophic) level" or both. It was not acceptable for a candidate to mix and match, for example, by stating "secondary consumer or fourth level" or for detail to be lacking or ambiguous, for example "tertiary" or '3'. One common error was to state "second" instead of "secondary consumer".

(iii) This question was a good example of the importance of giving an unambiguous and well-expressed response in order to get the correct ideas across. Some candidates did this very well, and if they considered both angles, intake of food for energy and energy available after losses, they were able to gain full credit. Most candidates focused their response either on the idea of feeding *or* on energy losses. It was not correct to make a general statement that not much energy was lost by the group of organisms on each trophic level, as there was no information provided about this. However, it was correct to state that, as energy was lost at each level, there was an advantage to the whale to be in a short food chain in order to maximise energy intake. Some candidates knew that there would be fewer indigestible parts in an aquatic food web, so decreasing energy loss between each link of the food chain. Stronger responses avoided misleading or poor descriptions such as "the whale gets enough energy by eating two animals", "all the energy from the phytoplankton ends up in the whale" and "the whale gets double the energy by eating krill and herring". Weaker candidates suggested that very little or no energy was lost in the food web and a number used the "10%" value to surmise that the herring and the krill gained 10% each of the energy from the phytoplankton so that the whale could end up with 20% of the energy. A few candidates did not answer the question and wrote about how the whale could conserve energy or focused on the different ways that energy is lost.

(b) Those candidates that realised that **(b)** was about the role of triglycerides as an energy store and for thermal insulation had no problems in gaining full credit. Many candidates, however, simply repeated the information given in the introduction of the question and wrote about food stores being used up or gained. Some thought that the stores were glycogen even though they had been advised that blubber was a layer of fat-filled cells, while others thought that the primary focus of the changing blubber thickness was for insulation and did not note the importance of the layer as an energy store that could be mobilised during non-feeding times.

(c) Many candidates knew sufficient about the role of water as an external environment for organisms to gain full credit for part **(c)**. Of these, a good proportion of excellent responses were seen. These were well-expressed, covering many of the ideas that were required, and used the organisms in **Fig. 3.1** to exemplify the role of water. Some candidates wrote about the roles of water in living organisms rather than the roles of water as an environment for organisms.

Question 4

Most candidates found this question, assessing ***Sections I*** and ***J***, to be accessible, but as the second half of this question required a higher level of thought, only stronger candidates produced high quality responses from **(b)(iii)** onwards.

(a) Well-prepared candidates had no difficulty completing correctly all of **Table 4.1**, including all terms spelled correctly and one or more species being given with the genus *Plasmodium.* The majority of candidates completed correctly two of the four blank boxes in **Table 4.1**. Almost all had correct

knowledge of the type of causative organism of TB. The majority could also give the name of the causative organism of HIV/AIDS. Flexibility was allowed in the spelling of this organism, but the whole term, "human immunodeficiency virus" was required in order to gain credit. A good number of candidates simply wrote "HIV". There were more problems for less confident candidates when completing the row for malaria. Many candidates incorrectly wrote "*Plasmodium*" in the "type of causative organism" column. It was not uncommon for the *Anopheles* mosquito to appear in either box for malaria. Many did not know that malaria is caused by a protoctist, giving instead the general term "parasite" instead. For those who used the term protoctist, a wide range of spellings were seen for this and credit was not awarded if the word given was too far removed from the actual term.

(b) (i) Almost all candidates gained credit for part **(i)**, although some gave tuberculosis in addition to cholera. In these cases only the first answer on the line was considered.

(ii) This was generally correct. Some candidates did not give a reason for their stated type of drug and could not gain credit. Others described the oral rehydration therapy used in the treatment of cholera and had not noticed that the question asked for a type of drug.

(iii) Many candidates focused only on suggesting how the vaccination programme was successful in protecting the vaccinated children against typhoid or ignored the idea of vaccination and gave general suggestions of how the incidence of disease may have been decreased by other means. The best responses considered the link between the vaccinated children and the reduction in numbers of non-vaccinated people: they began with explaining the advantages of a vaccine for the children vaccinated and then went on to describe how this caused a herd effect.

(c) (i) Only the minority of candidates realised that part **(i)** required an explanation of self-antigens and foreign or non-self antigens. These were easily able to gain full credit. Some candidates could explain that bacteria had foreign antigens but did not appear to know that human cells also possessed antigens. Some thought that human cells did not have antigens at all. Credit was given where candidates used the term foreign cell when referring to bacteria and later in their response noted that bacteria had antigens. Many responses went off-course and gave details of recognition by T-lymphocytes or B-lymphocytes or incorrectly stated that phagocytes produced antibodies.

(ii) The candidates who had shown an understanding of phagocytosis in part **(i)** were often able to give a sensible suggestion in **(ii)**, usually linked to averting digestion by the hydrolytic enzymes within the lysosomes of the phagocytes. The introduction to part **(c)** had already informed candidates that the typhoid bacteria had been engulfed by the phagocytes, a point that had not been noted by those who suggested antigenic concealment in other cells to avoid phagocytosis. Some knew that the bacteria were inside the phagocyte but ignored the fact that they should have been destroyed and simply stated that they would multiply by mitosis using the resources of the host cell.

(iii) Almost all candidates realised that people with HIV/AIDS would have a weakened immune system. There was considerable flexibility in the various ways that this idea could be expressed, but for full credit, a deeper understanding of the situation was required. Stronger candidates were able to give good explanations based on the decrease in numbers of T helper cells and the knock-on effect of this.

Question 5

Syllabus ***sections C, E*** and ***F***, were assessed in this question. Candidates who were skilled in using their knowledge and understanding of the syllabus to answer questions that required two or more stages in their train of thought were able to perform well. For all sections of **Question 5** it was very important to understand the requirements of the question.

(a) Complete clarity was required in this response in order to display a good understanding and gain full credit. Common errors were to state that there were "hydrogen bonds between bases" but not make it clear that they were between complementary bases or base pairs and that the importance of this was that this held together the two strands of the DNA molecule. It was not sufficient to say that the hydrogen bonds held together the DNA double helix as this could also have referred to the sugar-phosphate backbones. Very few candidates understood that, although individually weak, a large number of hydrogen bonds would provide overall strength. Many thought that hydrogen bonds were strong bonds. Only a few candidates stated that the strong phosphodiester bonds between adjacent nucleotides on a polynucleotide chain would also provide stability. A very large

proportion read this question as "Describe the structure of DNA" and made no attempt to pick out the features of the structure that provided stability to the DNA molecule, while others wrote about the two polypeptide chains of the DNA double helix.

(b) This was answered fluently by some candidates who gave a number of considered points and gained full credit. Many other candidates did not show a good understanding of what was required. For these, partial credit was awarded for knowledge that the presence of a gene or DNA was required for polypeptide or protein synthesis. A number of weaker candidates thought that they should give an outline of transcription and translation.

(c) This was answered correctly by the majority of candidates.

(d) The very best candidates were able to provide details of the type of mutation that had occurred, state the differences occurring in the base sequence of the two alleles and explain how this would lead to altered codons and hence the replacement of glutamine with valine in the polypeptide. Very few candidates gained full credit for part **(d)**, mainly owing to a lack of care in reading the question. The majority gave a description of the differences between the two types of haemoglobin and the physiological consequences of this, despite being asked in the question for a description and explanation of the difference between the two alleles. At best these candidates gained some credit for knowing that valine replaced glutamine.

(e) Candidates were asked to explain the results of the investigation. Some candidates concentrated mainly on extracting data from **Fig. 5.1** and described the results of the investigation, which was not required. A summary of the results was all that was necessary in order to progress to a logical explanation in terms of mode of action of enzymes. There were numerous examples of good explanations of the effect of enzyme inhibitors and many gained full credit. Although **Fig. 5.1** and the chemical's name of "ara-ATP" suggested competitive inhibition was occurring, the fact that the substrate concentration did not increase to an extent to allow candidates to ascertain whether competitive or non-competitive inhibition was occurring, responses explaining either type of inhibition was accepted.

Question 6

This question, assessing ***Sections G*** and ***H***, was quite challenging for many candidates. In **(a)**, knowledge of heart structure from an external perspective was less well known than internal heart structure.

(a) A large number of candidates were able to gain full credit, although some weaker candidates were able to correctly identify only one feature – this was usually either the right atrium or a coronary artery.

(b) Candidates needed to have returned to the information at the beginning of the question, which explained that this was a "bypass" surgery, before answering this question. A minority of candidates placed an **X** in a correct location on **Fig. 6.1**. Many put an **X** elsewhere on a coronary artery so that the graft could not bypass the problem, and a number placed it in a correctly labelled internal mammary artery, both of which would defeat the purpose of the surgery. For many the placement of the letter **X** seemed to be guesswork.

(c) Only some candidates understood the learning outcome on which this question was based and produced a thoughtful discussion about the difficulties in achieving a balance between prevention and cure. As the surgery was to bypass a diseased coronary artery, candidates were expected to discuss prevention of the condition to avoid surgery and curing the condition with the surgery, and to include in the discussion the problems with both approaches. The strongest candidates expressed themselves well and gained full credit. Others were able to gain partial credit with a brief discussion of ways of preventing the condition, but fewer wrote about the problems with prevention. For those that focused on problems with the surgery, expense and possible problems with tissue rejection was commonly mentioned. Some candidates wrote about heart transplants while others thought that the high pressure of the blood would cause the internal mammary artery to burst.

BIOLOGY

Paper 9700/23
AS Structured Questions

Key messages

Candidates should allocate sufficient time to ensure that they fully understand graphs, diagrams and photographs accompanying a question, and should refer back to these when constructing a response.

Candidates should be guided by the wording of the question, for example "State the…" will require a briefer response than "Outline the …." or "Describe the…". These terms and others are clearly explained in the syllabus and should be conveyed to all the candidates. Candidates should also be encouraged to use correct scientific terminology as this will often save time and produce a concise, well-expressed response. In questions that require a comparative answer, words such as lowest, greatest and highest should be used to gain maximum credit.

Where chemical symbols are used instead of writing out words, these must be correct; for example, NH_3 would gain credit whereas NH_3^- would not. In general, it is better to use words and only use symbols for equations and diagrams.

Candidates should always check that they have answered all the questions on the paper. In this case, **Question 2 (a)** was omitted by a significant number of candidates.

General comments

This proved to be a very approachable paper and many answers were written with great confidence. All candidates completed the paper indicating that there was sufficient time to cover all questions. The best candidates were very good at sequencing answers and presenting their information in a logical order. Almost all candidates attempted all of the part questions.

Many candidates had a good grasp of the syllabus learning outcomes and were able to access those questions assessing knowledge and understanding. The same candidates made a good attempt at those questions requiring skills from Assessment Objective B but found these to be much more challenging. Less well-prepared candidates were able to gain partial credit on the more straightforward questions requiring knowledge of the less conceptual syllabus learning outcomes. These candidates would have benefited from developing their analytical skills and tackling questions that required them to apply knowledge in a novel context. Weaker candidates tended to gain credit on the more straightforward, shorter questions.

The questions differentiated well, with most of them based on a theme that allowed learning outcomes from different sections of the syllabus to be assessed. Generally, candidates made good use of the lines provided for written responses. Responses from a number of candidates were not always easily legible. Many candidates clearly identified where to begin and end answers which required multiple, sequenced points.
Biological knowledge needs to be applied to the specific question asked. Full credit will not be gained for simply recalling detailed knowledge that does not answer the question asked. This was particularly the case on **Question 4 (c)** where many candidates described water moving up the xylem in great detail, and also in **Question 5 (c)** where many candidates wrote about mutations and cancer or sickle cell or even how the sequence of amino acids would be changed, but did not link it to **Fig. 5.1** so did not gain any credit.

Comments on specific questions

Question 1

This proved to be a straightforward question as almost all the candidates identified the organelles in **Fig. 1.1** correctly and gave each a suitable function. If the identification was not correct, credit was not allowed for a correct function of the organelle that was given. However, there were two exceptions to this. **B** (Golgi body) was occasionally identified as a lysosome. Since the electron micrograph showed some vesicles which could well be lysosomes, a correct function of the lysosome was given credit. **E** (rough endoplasmic reticulum) was sometimes identified as the smooth endoplasmic reticulum. Correct functions of the SER were given credit.

A common error was to state the function of **A** (mitochondrion) as the "production of energy" or the "site of respiration". "Produce energy", whenever used, never gains credit, and "respiration" in this context is not precise enough as it should have been qualified by reference to "aerobic" respiration. Stronger candidates correctly referred to the production of ATP, rather than "ATP energy". **B** (Golgi body) was the structure that was most frequently misidentified. The most common incorrect response for **B** was "endoplasmic reticulum". The functions of the Golgi body were often given as the "modification or packaging of macromolecules". This idea only gained credit if qualified by reference to proteins or lipids. There was considerable confusion over the role of the Golgi body, with many stating that it synthesises lipids.

Question 2

This question proved the most challenging for many candidates, particularly part **(c)**.

(a) Credit was given if both cholera and tuberculosis were underlined. In fact, antibiotics are also used in the treatment of malaria and HIV/AIDS so if these were underlined in addition to cholera and tuberculosis, credit was also given. It was not uncommon to find cholera, malaria and tuberculosis as the diseases indicated. Many candidates only identified tuberculosis.

(b) Many candidates gave very full answers to this question, explaining the reasons for completing the course of antibiotics. Many stated that bacteria need to be eliminated so there is no reservoir of infection left in the body. Many also wrote about the possibility of resistance developing among any bacteria left in the body if a person stops the course when they feel better. Some referred to the mutation of bacteria although few candidates were able to link this development of resistance to a mutation occurring. Less successful candidates did not gain full or partial credit here because they stated that antibiotics remove viruses from the body or just referred in general to pathogens or antigens. Bacteria were often said to become 'immune' to the antibiotics. Some candidates wrote that the antibiotic caused the mutation. Others referred to the increased spread of the disease after antibiotic resistance had occurred.

(c) (i) The descriptions of competitive inhibitors were not always very good. Many candidates stated that the inhibitors have a shape that is the same as or similar to that of the substrate or that they have a complementary shape to the active site. Often, however, candidates stated that these inhibitors have the 'same shape' as the substrate and that they bind to places *other than* the active site. Few candidates continued their argument by stating that the effect of this inhibition is to reduce the formation of enzyme-substrate complexes and reduce the rate of reaction. A few candidates interpreted the question by describing the action of one inhibitor molecule in stopping the formation of an enzyme-substrate complex and were able to gain credit for this. Many also stated that the effects of a competitive inhibitor could be overcome or reduced by increasing the substrate concentration. This was not credited as it was not relevant in terms of describing a competitive inhibitor.

(ii) This was not well answered, even by candidates who had written excellent answers to part **(i)**. A few candidates applied their knowledge of the specificity of enzymes to this question, by stating that human cells do not have cell walls and therefore have no need for the enzyme that is inhibited by penicillin.

(iii) Responses to part **(iii)** occasionally showed confusion with penicillinase, which was the subject of a question in a recent paper (June 2012). Some thought that penicillin inhibited penicillinase. Generally the best candidates gained full credit here by describing what happens to bacteria that are treated with penicillin. Many candidates simply repeated their answers from part **(i)**. Answers

which simply stated that antibiotics are not harmful to humans were common, but lacked the detail required to gain credit. Many candidates made reference to penicillin 'punching holes' in bacteria cell walls. Many also described the effect of a "weakened" cell wall making the bacteria increasingly vulnerable to macrophages, which was not credited. Some lost credit by stating that the bacteria die without linking this to the entry of water by osmosis.

Question 3

Part **(a)** of this question proved the most challenging for the majority of candidates. Many candidates explained why there was the link between smoking and lung cancer in considerable detail, correctly describing the effects of smoking on the lungs and how lung cancer develops. This did not gain credit as the question asked candidates to explain what the results show about the link, rather than why there was this link. The answers to part **(b)** were often very good indeed.

(a) Candidates had to decide what aspects of the evidence for the link between smoking and lung cancer were shown in **Fig. 3.1**. Candidates most often identified the length of time that people spend smoking and the number of cigarettes that they smoked per day. The Examiners also expected the candidates to note that the data shows that the *lowest* death rate is for those people who have never smoked. Candidates often said that the death rate for these people was low rather than the lowest for the categories shown. Other points that were also missed by most candidates were:

- those with the highest death rate are the heaviest smokers who start at the youngest age, and
- the greatest difference between the percentage deaths for different quantities of cigarettes smoked per day occurs at the youngest age.

Credit was not given for quoting data from **Fig. 3.1** in support of the statements. There were four clear points that candidates should identify from the graph. Some candidates confined their answer to a description of the graph. Many candidates gave various reasons for the pattern seen in the data, none of which were required and therefore none of which were given credit. Candidates often gave detail concerning the effects of cigarette smoke on the lungs and attempted to explain how that more cigarettes smoked, or smoking from an early age was more likely to lead to cancer and suggested passive smoking to be the reason why non-smokers developed lung cancer. Some did not interpret the data correctly and suggested that 'younger smokers' have an underdeveloped immune system compared with the 'older smokers' and that perhaps older people were more aware of the dangers of cigarette smoking.

(b) Answers to this part-question were often concise and well written.

(i) Many candidates correctly stated that carbon monoxide binds to haemoglobin to form carboxyhaemoglobin. Very occasionally carbaminohaemoglobin was given in error. Many candidates explained that binding of carbon monoxide to haemoglobin is permanent and that this reduces the oxygen transported in the blood. Many candidates went on to say that the effect of carboxyhaemoglobin formation was the reduction in oxygen supply specifically to the heart muscle, as opposed to the body in general. Where reference was made to the damage to arteries, candidates' answers generally lacked specificity and referred to "blood vessels". There were many examples where candidates were not careful with their responses, for example "carbon monoxide binds or has a high affinity to oxygen". Other suggestions also not credited included carbon monoxide binding to blood or to red blood cells.

(ii) The effects of nicotine were generally well known and many candidates gained credit for stating its effect on heart rate, blood pressure and blood clotting. Some candidates failed to read the question carefully and wrote about the effects of nicotine on the adrenal gland, which is not part of the cardiovascular system. Those who stated that nicotine stimulates the secretion of adrenalin often gained full credit by giving the effects of this on the cardiovascular system. It was quite common for candidates to make reference to nicotine reducing the diameter of blood vessels rather than the arterioles. A significant number of candidates made the correct reference to the increased "stickiness" of platelets but did not go on to qualify the effects of this in order to gain credit.

(iii) Answers to part **(iii)** were not always as good as those to **(i)** and **(ii)**, with candidates often stating that tar stimulates an increase in the secretion of mucus by goblet cells, but not that the cells enlarge as a result. Similarly, they stated that cilia are paralysed or destroyed, but not that this

means mucus is moved slowly, if at all, in the airways. Goblet cells were occasionally stated to be 'inflamed' – an idea that was not correct since inflammation is a response of tissues.

Question 4

There were many high scoring answers to this question, although some candidates were not very precise with their answers to parts **(b)** and **(c)**. It was clear that candidates knew how xylem vessels are adapted to their function and how water travels from the xylem in a leaf to the atmosphere. However, answers tended to be poorly worded, with incomplete or incorrect use of the terminology required.

(a) Almost all candidates calculated the magnification of the scanning electron micrograph in **Fig. 4.1** correctly as x 400. A mistake that is often found in this type of question is measuring the scale bar in centimetres and not converting correctly to millimetres. There were few of these mistakes this time. Some candidates tried to use the scale bar to measure the width of a xylem vessel, but did not use the scale bar correctly to do this.

(b) Most candidates gave one or two features of xylem vessels, but often were not able to explain adequately how these features allow the movement of water in plants. A common error was to explain that lignin strengthens cell walls to prevent vessels from bursting and that lignin allows adhesion of water molecules to the walls of the vessels. It was less common to find three correct features each linked successfully to an explanation.

(c) Some candidates gave excellent explanations of water movement from xylem vessels in the leaf to the atmosphere. Descriptions of the pathway were not always as good. Candidates often simply stated that water travels via the apoplast and/or symplast pathways without any further description. It was often not clear where in the leaf evaporation occurs. There were few answers that made this clear as the cell walls (or surface) of the mesophyll cells. The movement of water vapour into the air spaces within the leaf and then its diffusion through the stomata were often described very well. Many candidates also included reference to a water potential gradient. A number of candidates did not identify the point at which they needed to start this answer and consequently included a great deal of irrelevant detail; for example, some candidates failed to gain full credit as they wrote detailed descriptions of the movement of water up xylem vessels or across the root which was not relevant. Answers from weaker candidates revealed much confusion between evaporation and the diffusion of water vapour out of the leaf. These answers often included incorrect references to Casparian strips in the leaves.

Question 5

As with **Question 2**, the last part often proved the most difficult for candidates.

(a) There were many good, detailed accounts of translation. However, as the question asked about the role of the ribosome, some of these accounts often included unnecessary information. The ideas that the tRNA anticodon binds to the codon on mRNA and that a peptide bond is formed between amino acids were generally well known. Many candidates did not begin their answer by stating that mRNA attaches to the ribosome at the start of translation. Others did this in some detail, referring to the large and small subunits of the ribosome. Frequently, there was no general explanation about the role of the ribosome in translating the sequence of codons into a sequence of amino acids. Confusion often surrounded the role of the tRNA molecules as rarely was it made clear that each type of tRNA, with its specific anticodon, carries a specific amino acid. Candidates often made the mistake of stating that the ribosome has space for six codons rather than two codons comprising six nucleotides. There were some very good answers that referred to the P and A sites within the ribosome and explained that peptide bond formation is catalysed by peptidyl transferase. A number of candidates wrote about the E (exit) site as well. There were also references to polyribosomes.

(b) Almost all candidates identified the two base sequences as GGC and CTA. Most commonly it was the second of these that was incorrect; a common mistake was to give CUA.

(c) This part-question proved a good discriminator. Good candidates were able to apply their knowledge of base sequences and the genetic code to work out what would happen in this frameshift mutation. Many stated that the deletion of the U at the beginning of **codon 2** would mean that this would code for a different amino acid. Few then continued the argument to explain the effect on all subsequent codons and the amino acids for which they code. Some realised that

one of the 'new' codons might be a stop codon and that this would lead to a much shorter polypeptide. Others realised that a totally different amino acid sequence is likely to result in a non-functional protein. Weaker candidates tended to be too vague, stating that genes or DNA base sequences would change rather than making it clear that the amino acid sequence and the subsequent protein produced would change. Many thought that the codon would now only have two bases.

A common response from weaker candidates was to simply give a general statement about the effects of mutations, with no reference to the figure or to try to relate it to diseases included in learning outcomes that are caused by mutation, such as cancer and sickle cell anaemia. Many candidates referred to the tRNA anti-codon no longer being complementary, but did not go on to explain that a different tRNA with a different amino acid would be involved. Some candidates identified that **codon 2** was a stop codon and therefore one effect of the frameshift was continued translation. Others wrote out the remaining codons, simply leaving out the U and suggesting the amino acid from **codon 2** was deleted. A common misconception was that deletion leaves two bases which does not code for an amino acid so the translation of the protein would therefore stop at this point.

Question 6

Most candidates gained full, or almost full, credit on this question as they were able to interpret the food web correctly and applied their knowledge of the cycling of nitrogen to the information given in part **(d)**.

(a) There were many precise definitions of the term *ecosystem*. Candidates tended to lose marks for carelessness, such as 'all the living and non-living organisms in a particular place'. Many gave references to interactions between organisms and abiotic components, but descriptions of an identifiable or self-contained area were less clear.

(b) Almost all candidates identified the producers correctly. Incorrect answers often showed that candidates had not read the question carefully. "Plants" was seen on a few scripts, for example. There was less success with identifying those organisms feeding *only* as secondary consumers. Spiders and predatory insects were the correct answers; frogs, toads and foxes were given quite often.

(c) The loss of energy in food chains was often explained very well indeed. The lucidity of the answers was quite variable, with some being no more than lists. If the ideas were expressed clearly, credit was given. Candidates need to take care when using respiration as an example here as many lost credit by saying that respiration *uses* energy.

(d) A number of candidates interpreted this question correctly and give three or four relevant points often in some considerable detail. Many started their answers by referring to dead animals from the top of the food web or their excreta or egesta. What was often missing was a clear description of the steps involved in the production of ammonia or ammonium ions by deamination of amino acids. Candidates could either state that this happens in the top predator in the production of urea or in the bacteria that feed on proteins in the dead bodies or egesta. Nitrification was often explained very well. Weaker candidates tended to be confused between nitrification and nitrogen fixation. A few candidates wrote that proteins are deaminated into amino acids. Most candidates knew that decomposers broke down the dead material, but very few were aware that amino acids produced by this process would be used by the decomposers for growth.

BIOLOGY

Paper 9700/31

Advanced Practical Skills 1

Key Messages

Candidates should be given the opportunity to experience a variety of practical work throughout the course, in order to develop the skills that can be applied to the requirements of the examination. They should also be given the opportunity to reflect on this work in order that they are able to suggest improvements to their investigation that will improve the confidence in their results.

Candidates should be familiar with how to use the microscope provided in the examination and how to draw plan diagrams with no cells. When asked to draw cells candidates should follow instructions carefully to draw the required number of the correct cells, using a suitable pencil to obtain clear sharp lines.

Candidates should be encouraged to understand the terms in the question. For example the term 'explain' should be understood to mean that scientific reasons are required to explain why, for example, a graph has a particular trend. This term and others are clearly explained in the syllabus and should be conveyed to all the candidates.

General Comments

The majority of Centres returned the Supervisor's report with the results obtained and seating plan with the candidate papers. The information included in the Supervisor's report is essential, as any problems encountered by the candidates, or factors such as the temperature in the laboratory can be taken into account when marking the candidates' scripts.

Candidates who have used similar materials and apparatus during practical work as part of the course are likely to perform better in the examination. Whilst the procedure in the examination may not be familiar, candidates who have had the opportunity to use similar materials and apparatus are likely to find it easier to organise and manipulate unfamiliar material.

Preparing the correct materials and providing the specified apparatus is essential for the success of the examination. Centres are reminded that they should contact CIE if any problems are encountered when supplying the materials or apparatus. To ensure that candidates do not have difficulty in meeting the skills criteria, there should be no changes to either the materials or apparatus without prior consultation with CIE. Any necessary checks on the materials prior to the examination will be included in the Confidential Instructions.

It is important that each candidate receives fresh supplies of materials and apparatus where applicable. Extra supplies of solutions and materials should be made available for any candidate who requests them. It is important that these solutions and materials are labelled only as specified in the Confidential Instructions.

In general, many candidates demonstrated that they had a good understanding of the skills required. There was good discrimination between the weaker and more able candidates and the majority of candidates showed that they were familiar with the use of the microscope.

Candidates who had read the whole of each question before attempting it were more able to plan their time carefully and answer the specific questions accurately.

Candidates and Supervisors should not be concerned if the results obtained are very variable, as consistency of results within a Centre is not being assessed.

Comments on Specific Questions

Question 1

(a) (i) The majority of candidates, who had been provided with the correct apparatus, were able to select a suitable volume of water.

(ii) Many candidates correctly identified the four concentrations they needed to prepare as 0.5%, 0.25%, 0.125% and 0.0625%. The most common error was to state 0.625% as the final concentration.

Only the better candidates were able to show the correct use of the 1.0% solution provided (**G**) in a serial dilution, where 1.0% is only used for the preparation of the first concentration, in this case 0.5%. These candidates were also able to show 10 cm^3 of water being added to each beaker.

(iii) The candidates who are familiar with carrying out investigations presented their results most clearly and gained most credit.

The majority of candidates organized their results clearly by presenting a fully ruled table with all the cells drawn, and a ruled outer boundary. The better candidates included an appropriately detailed heading for the independent variable (percentage concentration of **G**) and the dependent variable (time/s). The most common errors were to head the column for the independent variable 'solution' or omit the values for the independent variable in the table and replace them with letters such as G1 and G2.

The majority of candidates gained credit for recording at least four results as whole numbers. The better candidates recorded the correct pattern of results with 1.0% producing the first colour change in a shorter time than the lowest concentration investigated.

(iv) The better candidates were able to show the correct positions of each of the percentage concentrations of solution **G** on Fig. 1.3, with 0.25% positioned in the centre of the scale line and 0.125% half way between 0.25% and 0.0625%. These candidates were then able to place **S** in the most appropriate position on the line using their results. The most common error was to place the concentrations incorrectly on the line, so that 0.25% was not positioned centrally.

(v) The majority of candidates were able to suggest appropriate improvements to this investigation. The most common answers to gain credit were to identify the need to repeat the investigation and the need to investigate more concentrations of glucose solution. The better candidates identified the need to leave the Visking tubing in the water longer. The most common error was to identify the need for a constant temperature in the water-bath used to heat the Benedict's, but not identify how this should be done, i.e. using a thermostatically-controlled water-bath.

(b) (i) The majority of candidates drew the graph, using the headings given in the table, with concentration of glucose solution / arbitrary units on the *x*-axis and absorbance of light / arbitrary units on the *y*-axis.

The better candidates used scales of 2 cm to 5 arbitrary units for concentration of glucose and 2 cm to 0.500 arbitrary units for absorbance of light, plotted the points exactly with a small cross or dot in a circle and drew a sharp, clear ruled line accurately connecting each pair of points.

The most common errors were not including a full axis label for each axis, omitting the units for both the *x*-axis and the *y*-axis, omitting to label the origin when it had a value other than zero, not labelling the scale every 2 cm, plotting points which were just blobs or too large or too small (point not visible when line drawn through it), and drawing lines which were too thick or not ruled.

As a general rule, lines should not be extrapolated.

(ii) The best candidates were able to identify that the reason for the difference in the results was that there was faster diffusion at 15 arbitrary units as there was a steeper diffusion gradient.

Many candidates described the difference in light absorbance at each of the two concentrations of glucose but were unable to gain credit as an explanation of this difference was required.

(iii) The best candidates correctly identified that the difference in the gradient of the line between 10 and 25 arbitrary units and between 25 and 30 arbitrary units was due to a limiting factor such as the idea that the dye had reached its deepest colour intensity.

The most common error was to describe the change in light absorbed, without giving a reason for this change.

(iv) Many candidates correctly identified the actual error in measuring a volume of 5 cm^3 as +/- 0.1 cm^3.

Question 2

(a) (i) The majority of candidates were able to state that the specimen on **J1** was a root because it had central vascular tissue.

(ii) The better candidates produced drawings made using a sharp pencil to produce clear, sharp lines which joined up neatly, did not include any shading and used most of the space provided without drawing over the text of the question. Within the endodermis there was irregular vascular tissue which the better candidates had observed by using the higher power of the microscope to identify the different tissues. Some candidates had used the eyepiece graticules to help them draw well-proportioned drawings.

The most common errors were drawn lines that did not meet up precisely or were too thick, inclusion of cells, and incorrect identification of the cortex.

(iii) The better candidates identified the correct cells and used clear, sharp lines to show the four complete xylem vessels with their thick cell walls, drawn with a middle lamella where each cell touched the next. The majority of candidates gained credit for correctly identifying the lumen and many were able to annotate the drawing with one observable feature such as thick walls or hollow lumen.

(b) Many candidates were able to use Fig. 2.1 and correctly completed step 1 giving an answer of 0.01 mm.

The answer to step 1 was then transferred into step 2 and multiplied by 1000 to give the correct answer in μm.

(b) (ii) Those candidates who had experience of using the calibration of an eyepiece graticule were able to show the correct measurement of the length of the plant tissue from **X** to **Y** using the eyepiece graticule scale in Fig. 2.3 and show the multiplication by the answer to step 2.

(c) The better candidates recorded observations using the most appropriate organisation, which included one column for listing the features and two additional columns, one headed **J1** and the other headed Fig. 2.3. The majority of candidates were able to gain partial credit for recording appropriate differences. The most common errors were to include similarities or to incorrectly identify the tissues or identify differences in only one type of tissue.

BIOLOGY

Paper 9700/33

Advanced Practical Skills 1

Key Messages

Candidates should be encouraged to learn the methods for the tests for biological molecules as specified in the syllabus. For the Benedict's test the volume of Benedict's solution must be the same or more than the volume of the sample being tested and the temperature of the water-bath maintained at 80°C or up to 100°C. As this test was being used to compare reducing sugar concentrations and a sample from the seeds, the temperature needed to be constant for all tests.

Candidates should be given the opportunity to experience a variety of practical work throughout the course, in order to develop the skills that can be applied to the requirements of the examination. They should also be given opportunities to reflect on this work in order to modify a particular procedure to study a different variable by keeping the previous independent variable constant and then changing the independent variable. In this question paper this should be by suggesting at least five temperatures maintained using a thermostatically-controlled water-bath.

Candidates should be familiar with how to use the microscope provided in the examination and how to draw plan diagrams with no cells. When asked to draw cells candidates should follow instructions carefully to draw the required number of the correct cells, using a suitable pencil to obtain clear sharp lines.

General Comments

The majority of Centres returned the Supervisor's report with the results obtained and seating plan with the candidate papers. The information included in the Supervisor's report is essential, as any problems encountered by the candidates, or factors such as the temperature in the laboratory can be taken into account when marking the candidates' scripts.

Candidates who have used similar materials and apparatus during practical work as part of the course are likely to perform better in the examination. Whilst the procedure in the examination may not be familiar, candidates who have had the opportunity to use similar materials and apparatus are likely to find it easier to organise and manipulate unfamiliar material.

Preparing the correct materials and providing the specified apparatus is essential for the success of the examination. The majority of Centres provided all the materials required and the majority of the candidates experienced no problems when completing the question paper.

Centres are reminded that they should contact CIE if any problems are encountered when supplying the materials or apparatus. To ensure that candidates do not have difficulty in meeting the skills criteria, there should be no changes to either the materials or apparatus without prior consultation with CIE. Any necessary checks on the materials prior to the examination will be included in the Confidential Instructions.

It is important that each candidate receives fresh supplies of materials and apparatus where applicable. Extra supplies of solutions and materials should be made available for any candidate who requests them. It is important that these solutions and materials are labelled only as specified in the Confidential Instructions.

In general, many candidates demonstrated that they had a good understanding of the skills required. There was good discrimination between the weaker and more able candidates and the majority of candidates showed that they were familiar with the use of the microscope.

Candidates who had read the whole of each question before attempting it were more able to plan their time carefully and answer the specific questions accurately.

Candidates and Supervisors should not be concerned if the results obtained are very variable, as consistency of results within a Centre is not being assessed.

Comments on Specific Questions

Question 1

(a) (i) Many candidates correctly suggested that the size of the seed should be standardised.

(ii) Many candidates decided on a correct temperature between 80°C and 100°C.

(iii) Many candidates identified the need to prepare 10 cm^3 of solution for each concentration.

The better candidates correctly selected the three concentrations which had 0.1% difference between them, and showed the correct use of the 0.4% solution provided (**R**) as a simple dilution where **R** was used in the preparation of each concentration and the correct volume of water added.

This information was most clearly provided as a table.

(iv) Many candidates read the question carefully and decided that to compare the concentrations of **R** with the sample from the seeds which was given as 2 cm^3 then the volume of **R** tested must be the same and then the volume of Benedict's solution 2 cm^3 or more. Most candidates decided on a volume of Benedict's of no more than 5 cm^3.

(v) The majority of candidates organised their results clearly by presenting a fully ruled table with all the cells drawn, a ruled outer boundary and appropriately detailed headings for the independent variable (concentration of **R** / %) and the dependent variable (time / s). In addition, many candidates recorded at least three different concentrations and recorded their results in whole seconds. The majority of candidates gained credit for the correct pattern of results, with 0.4% producing the first colour change in the shortest time.

Those candidates who are familiar with carrying out investigations presented their results most clearly and gained most credit. The most common errors were to give an incomplete heading for the concentration, to include method details in the table, such as volumes of solutions used, to write units next to each value of concentration or each recorded time and to record the results in minutes or fractions of seconds.

(vi) The better candidates correctly estimated the concentration of reducing sugars using their results and the concentrations used. Candidates should be encouraged to estimate using only the concentrations used.

(vii) The majority of candidates correctly used their results to answer this question.

(b) The better candidates correctly modified this procedure to investigate the effect of temperature on the release of the enzymes in the seeds using at least five temperatures maintained by thermostatically controlled water-baths or using hot and cold water and a thermometer to check the temperature. Some candidates incorrectly altered the temperature of the water-bath for the Benedict's test.

(c) (i) The majority of candidates drew the graph, using the headings given in the table, with 'pH' on the *x*-axis and 'concentration of reducing sugars / mmol hr^{-1}' on the *y*-axis.

The better candidates used scales of 2 cm to 1.0 for pH and 2 cm to 10 for mmol hr^{-1} concentration of reducing sugars, plotted the points exactly with a small cross or dot in a circle and drew a sharp, clear ruled line accurately connecting each pair of points.

The most common errors were not including the units for the *y*-axis, omitting to label the origin when it had a value other than zero, plotting points which were just blobs or too large or too small (point not visible when line drawn through it), and drawing lines which were too thick or not ruled and were not labelled bark or leaves.

As a general rule, lines should not be extrapolated.

(ii) Many candidates were able to describe the trend for the activity of the enzyme in the leaves.

(iii) The better candidates correctly explained that the enzyme was becoming denatured as the pH increased from pH 5.3 to pH 6.4.

Question 2

(a) (i) The better candidates produced drawings made using a sharp pencil to produce clear, sharp lines which joined up neatly, did not include any shading and used most of the space provided without drawing over the text of the question. Many were able to draw the epidermis as two lines and the endodermis as two lines. Within the endodermis there was irregular vascular tissue which the better candidates had observed by using the higher power of the microscope to identify the different tissues. Some candidates had used the eyepiece graticules to help them draw well-proportioned drawings.

The most common errors were drawn lines that did not meet up precisely or were too thick, not showing all the different tissues and their correct distribution, which would be observable using the microscope.

(ii) The better candidates identified the correct cells and used clear, sharp lines to show the five cells with their thin cell walls, drawn with a middle lamella where each cell touched the next.

(b) (i) Many candidates were able to use Fig. 2.1 and correctly completed step 1 giving an answer as 0.00N where N could be any number up to 9, depending on their actual figures.

The answer to step 1 was then transferred into step 2 and multiplied by 1000 to give the correct answer in μm.

(ii) Those candidates who had experience of using the calibration of an eyepiece graticule to find the actual length of cells were able to show the correct measurement of the cells using the eyepiece graticule scale in Fig. 2.2 and show the multiplication by the answer to step 2.

The better candidates recorded observations using the most appropriate organisation, which included one column for listing the features and two additional columns, one headed **K1** and the other headed Fig. 2.4. The majority of candidates were able to gain full credit for recording appropriate differences. The most common errors were to include similarities or to incorrectly identify the tissues or to include types of cells and not tissues.

BIOLOGY

Paper 9700/34

Advanced Practical Skills 2

Key Messages

Candidates should be given the opportunity to experience a variety of practical work throughout the course, in order to develop the skills that can be applied to the requirements of the examination. They should also be given opportunities to reflect on this work in order to modify a particular procedure to study a different variable by keeping the previous independent variable constant, for example concentration of **E**, and then changing the independent variable, for example pH by suggesting that at least five pHs are maintained using buffers.

Candidates should be familiar with how to use the microscope provided in the examination and how to draw plan diagrams with no cells. When asked to draw cells, candidates should follow instructions carefully to draw the required number of the correct cells, using a suitable pencil to obtain clear sharp lines.

Candidates should be encouraged to understand the terms used in questions. For example, if they are asked for 'accurate results' it means that they should obtain results as close as possible to the true value; if asked for an 'observation' the candidate should record what they can see; the term 'explain' should be understood to mean that scientific reasons are required to explain why, for example, the graph has a particular trend. These terms and others are clearly explained in the syllabus and should be conveyed to all the candidates.

General Comments

The majority of Centres returned the Supervisor's report with the results and seating plan with the candidate papers. The information included in the Supervisor's report is essential, as any problems encountered by the candidates, or factors such as the temperature in the laboratory can be taken into account when marking the candidates' scripts.

Candidates who have used similar materials and apparatus during practical work as part of the course are likely to perform better in the examination. Whilst the procedure in the examination may not be familiar, candidates who have had the opportunity to use similar materials and apparatus are likely to find it easier to organise and manipulate unfamiliar material.

Preparing the correct materials and providing the specified apparatus is essential for the success of the examination. The majority of Centres provided all the materials required and the majority of the candidates experienced no problems when completing the question paper.

Centres are reminded that they should contact CIE if any problems are encountered when supplying the materials or apparatus. To ensure that candidates do not have difficulty in meeting the skills criteria, there should be no changes to either the materials or apparatus without prior consultation with CIE. Any necessary checks on the materials prior to the examination will be included in the Confidential Instructions.

It is important that each candidate receives fresh supplies of materials and apparatus where applicable. Extra supplies of solutions and materials should be made available for any candidate who requests them. It is important that these solutions and materials are labelled only as specified in the Confidential Instructions.

In general, many candidates demonstrated that they had a good understanding of the skills required. There was good discrimination between the weaker and more able candidates, and the majority of candidates showed that they were familiar with the use of the microscope.

Candidates who had read the whole of each question before attempting it were more able to plan their time carefully. These candidates could then assess whether they had time to attempt repeats or replicates.

Candidates and Supervisors should not be concerned if the results obtained are very variable, as consistency of results within a Centre is not being assessed.

Comments on Specific Questions

Question 1

(a) (i) Many candidates identified the need to prepare 5 cm^3 of solution for each concentration.

The better candidates correctly selected the four concentrations which had 0.2% difference between them, and showed the correct use of the 1.0% solution provided (**E**) as a simple dilution where **E** was used in the preparation of each concentration and the correct volume of water added.

This information was most clearly provided as a table.

(ii) The majority of candidates described replacing the enzyme with the same volume of water, as the apparatus provided did not allow for heating the enzyme to denature it.

(iii) The majority of candidates organised their results clearly by presenting a fully ruled table with all the cells drawn, a ruled outer boundary and appropriately detailed headings for the independent variable, (percentage concentration of **E**), and the dependent variable, (time / s). In addition, many candidates also gained credit for the collection and recording of results for four concentrations as whole seconds.

The majority of candidates gained credit for the correct pattern of results with 1.0% producing the first colour change in the shortest time and recorded the control as 'more than 240'.

Those candidates who are familiar with carrying out investigations presented their results most clearly and gained most credit. The most common errors were to give an incomplete table heading for the concentration or to position the columns incorrectly.

(iv) Most candidates gained credit for giving the **one** most significant error as the difficulty of identifying the the end-point or when the solution went clear.

(v) The better candidates correctly modified this procedure to investigate the effect of pH using at least three different pHs and buffers. Some candidates correctly calculated the rate as 1/time or described plotting the graph of pH against time to identify the rate changes.

(b) (i) The majority of candidates drew the graph, using the headings given in the table, with 'time in minutes' on the *x*-axis and 'area of gelatine / mm^{2}' on the *y*-axis.

The better candidates used scales of 2 cm to 20 minutes for time and 2 cm to 50 for the area of gelatine, plotted the points exactly (as a small cross or dot in a circle) and drew a sharp, clear line accurately connecting each pair of points.

The most common errors were omitting the units for both the *x*-axis and *y*-axis, not including a value for the scale on each 2 cm of the axis, plotting points which were just blobs or too large or too small (point not visible when line drawn through it), and drawing lines which were too thick or not ruled and were not labelled pH 4.0 and pH 6.4.

As a general rule, lines should not be extrapolated.

(ii) The better candidates described the trends shown by the data as the effect of the length of time on the area of gelatine.

(iii) The better candidates correctly explained that pH 4.0 was nearer to the optimum pH because the enzyme activity was greater than at pH 6.4 so more enzyme-substrate complexes were formed.

Question 2

(a) (i) The better candidates produced drawings made using a sharp pencil to produce clear, sharp lines which joined up neatly, did not include any shading and used most of the space provided without drawing over the text of the question. Many were able to draw the layers of different tissues within the leaf section. Within the vascular tissue several regions were observable which the better candidates had viewed by using the higher power of the microscope to identify the different tissues. Some candidates had used the eyepiece graticules to help them draw well-proportioned drawings.

The most common errors were drawn lines that did not meet up precisely or were too thick and not showing all the different tissues and their correct distribution, which would be observable using the microscope.

(ii) Those candidates who had experience of drawing cells as part of their course gained the most credit. Credit was awarded to candidates whose drawings were made using a sharp pencil to produce clear, sharp lines which joined up neatly, did not include any shading and used most of the space provided without drawing over the text of the question. The majority of candidates gained credit for carefully following the instructions selecting three complete touching palisade cells with irregular sizes and shapes, drawing each cell containing randomly arranged chloroplasts and drawing the thin cell walls.

The most common errors were to shade the nuclei, draw lines that did not join up or not draw the cell walls as double lines with a middle lamella between adjacent cells. Candidates should be encouraged to draw what they observe on the particular slide provided.

(b) The better candidates showed the measurements of each line clearly with the units as mm, the division of the measurement of **Y** by the measurement for **Z** and presented the ratio correctly as a larger whole number : smaller whole number. This might have required showing multiplying both figures by the same number to return to whole numbers e.g. 1.6 : 1 becomes 1.6 x 5 and 1 x 5 to give the correct ratio of 8:5.

(c) (i/ii) The better candidates drew a clear plan diagram with no cells showing the distribution of the different tissues and labelling three different tissues or features with separate lines as **P**, **Q** and **R**. As instructed in the question the better candidates then described how the specimen in Fig. 2.4 was different from **M1** as a description by each letter.

BIOLOGY

Paper 9700/35

Advanced Practical Skills 1

Key Messages

Candidates should be given the opportunity to experience a variety of practical work throughout the course, in order to develop the skills that can be applied to the requirements of the examination. They should also be familiar with following instructions when carrying out investigations. As a consequence, the recording of results should reflect the steps in the method carried out and in this investigation the recording of the temperature for the test-tube containing **H**, **W** and **Y** should have been the first result recorded followed by the results for increasing concentrations of **C**.

Candidates should be familiar with how to use the microscope provided in the examination and how to draw plan diagrams with no cells and follow instructions carefully when asked to draw the required number of the correct cells, using a suitable pencil to obtain clear sharp lines.

Candidates should be encouraged to understand the terms used in questions. For example, the term 'explain' should be understood to mean that scientific reasons are required to explain why, for example, the graph has a particular trend. This term and others are clearly explained in the syllabus and should be conveyed to all the candidates.

General Comments

The majority of Centres returned the Supervisor's report with the results and seating plan with the candidate papers. The information included in the Supervisor's report is essential, as any problems encountered by the candidates, or factors such as the temperature in the laboratory can be taken into account when marking the candidates' scripts.

Candidates who have used similar materials and apparatus during practical work as part of the course are likely to perform better in the examination. Whilst the procedure in the examination may not be familiar, candidates who have had the opportunity to use similar materials and apparatus are likely to find it easier to organise and manipulate unfamiliar material.

Preparing the correct materials and providing the specified apparatus is essential for the success of the examination. The majority of Centres provided all the materials required and the majority of the candidates experienced no problems when completing the question paper.

Centres are reminded that they should contact CIE if any problems are encountered when supplying the materials or apparatus. To ensure that candidates do not have difficulty in meeting the skills criteria, there should be no changes to either the materials or apparatus without prior consultation with CIE. Any necessary checks on the materials prior to the examination will be included in the Confidential Instructions.

It is important that each candidate receives fresh supplies of materials and apparatus where applicable. Extra supplies of solutions and materials should be made available for any candidate who requests them. It is important that these solutions and materials are labelled only as specified in the Confidential Instructions.

In general, many candidates demonstrated that they had a good understanding of the skills required. There was good discrimination between the weaker and more able candidates, and the majority of candidates showed that they were familiar with the use of the microscope.

Candidates and Supervisors should not be concerned if the results obtained are very variable, as consistency of results within a Centre is not being assessed.

Comments on Specific Questions

Question 1

(a) (i) Many candidates completed Fig. 1.1 correctly to show **two** further concentrations of **C**. The better candidates correctly selected the next two concentrations (0.3% and 0.03%), showed the transfer of 1 cm^3 of the 0.3% solution to the next dilution and added 9 cm^3 of water to each of the two dilutions.

(ii) The majority of candidates organised their results clearly by presenting a fully ruled table with all the cells drawn, a ruled outer boundary and appropriately detailed headings for the independent variables, (percentage concentration of **C** or time / seconds), and the dependent variable, (temperature / °C). In addition, many candidates also gained credit for the collection and recording of results for at least four concentrations as whole numbers or to ±0.5°C.

The majority of candidates gained credit for the correct pattern of results for water, showing an increase in temperature after 210 seconds. Many candidates correctly ordered their table to show the results for water first followed by results for increasing concentrations of copper sulfate.

Those candidates who are familiar with carrying out investigations presented their results most clearly and gained most credit. The most common errors were to give an incomplete table heading for the concentration or time or to position the columns incorrectly.

(iii) The better candidates correctly explained that the 3% copper sulfate solution inhibited the enzyme-catalysed reaction.

(iv) Most candidates gained credit for giving the **two** most significant errors as the starting temperature for each concentration of copper sulfate was different and that the concentration of hydrogen peroxide may have changed throughout the experiment.

Candidates should be encouraged to read the questions carefully; only two errors were required here and any additional errors did not gain any credit.

(v) The candidates who considered the procedure carefully were able to suggest **three** improvements.

The majority suggested that the independent variable needed a greater range of concentrations of copper sulfate and a longer time to carry out the experiment. Many suggested that the temperature should be recorded using a thermometer with smaller divisions or using a data logger with a temperature sensor and that the test-tube should be insulated to reduce the loss of heat.

Candidates should be encouraged to read the questions carefully; only three improvements were required here and any additional improvements did not gain any credit.

(vi) Many candidates correctly described replacing copper sulfate with the same volume of water.

(vii) Most candidates stated that the value of the smallest division on the scale of their thermometer was 1°C and correctly stated the actual error was 0.5°C.

(b) (i) The majority of candidates drew the graph, using the headings given in the table, with 'concentration of catalase / arbitrary units' on the *x*-axis and 'absorbance of light by the coloured solution / arbitrary units' on the *y*-axis.

The better candidates used scales of 2 cm to 20 arbitrary units for concentration of catalase and 2 cm to 0.2 arbitrary units for the absorbance of light by the coloured solution, plotted the points exactly with a small cross or dot in a circle and drew a sharp, clear ruled line accurately connecting each pair of points.

The most common errors were omitting the units for both the *x*-axis and *y*-axis, not including a value for the scale on each 2 cm of the axis, plotting points which were just blobs or too large or too small (point not visible when line drawn through it), and drawing lines which were too thick or not ruled.

As a general rule, lines should not be extrapolated.

(ii) The better candidates explained that at first many enzyme-substrate-complexes were formed and later there was less substrate available.

Question 2

(a) The better candidates produced drawings made using a sharp pencil to produce clear, sharp lines which joined up neatly, did not include any shading and used most of the space provided without drawing over the text of the question. Within the section many regions were observable which the better candidates had viewed by using the higher power of the microscope to identify the different tissues. Some candidates had used the eyepiece graticules to help them draw well-proportioned drawings.

Many candidates gained credit for clearly showing at least five layers and labelling the lumen correctly.

The most common errors were drawing lines that were too thick and, for the annotation, not drawing label lines to show the location of the innermost and outermost layers with an observable difference between these layers.

(b) (i) Many candidates were able to use Fig. 2.2 and correctly completed step 1 giving the answer 0.004. The answer to step 1 was then transferred into step 2 and multiplied by 1000 to give the correct answer in μm.

(ii) Those candidates who had experience of using the calibration of an eyepiece graticule were able to show the correct measurement of the fold (**X** to **Z**) using the eyepiece graticule scale in Fig. 2.4 and showed the multiplication by the answer to step 2.

(c) Those candidates who had experience of drawing cells as part of their course gained the most credit. Credit was awarded to candidates whose drawings were made using a sharp pencil to produce clear, sharp lines which joined up neatly, did not include any shading and used most of the space provided without drawing over the text of the question. The majority of candidates gained credit for carefully following the instructions by drawing the four cells labelled **P** on Fig. 2.5, drawing each cell containing nuclei and drawing the thin cell walls.

Many candidates gained credit for clearly showing the cells and labelling one nucleus correctly.

The most common errors were shading the nuclei, drawing lines that did not join up or drawing the cell walls as a single line.

(d) The better candidates recorded observations using the most appropriate organisation which included one column for listing the features and two additional columns, one headed for **L1** and one for Fig. 2.6. They also correctly decided that observational differences were only those features which they could see in **L1** and Fig. 2.6.

Many candidates were able to gain full credit for recording appropriate differences. The most common error was to include named tissues that were not identifiable.

BIOLOGY

Paper 9700/36

Advanced Practical Skills 2

Key Messages

Candidates should be encouraged to understand the terms used in questions. For example, if they are asked for 'accurate results' it means that they should obtain results as close as possible to the true value; if asked for an 'observation' the candidate should record what they can see; the term 'explain' should be understood to mean that scientific reasons are required to explain why, for example, a graph has a particular trend. These terms and others are clearly explained in the syllabus and should be conveyed to all the candidates.

Candidates should be given the opportunity to experience a variety of practical work throughout the course, in order to develop the skills that can be applied to the requirements of the examination. They also need to be familiar with the practical investigations specified in the syllabus, for example investigating and explaining the effects of temperature, pH, enzyme concentration and substrate concentration on the rate of enzyme-catalysed reactions.

Candidates should be familiar with how to show their working in calculations and the key steps in their reasoning.

General Comments

The majority of Centres returned the Supervisor's report with the results and seating plan with the candidate papers. The information included in the Supervisor's report is essential, as any problems encountered by the candidates, or factors such as the temperature in the laboratory can be taken into account when marking the candidates' scripts.

Candidates who have used similar materials and apparatus during practical work as part of the course are likely to perform better in the examination. Whilst the actual procedures used in the examination may not be familiar, candidates who have had the opportunity to use similar materials and apparatus are likely to find it easier to organise and manipulate unfamiliar material.

Preparing the correct materials and providing the specified apparatus is essential for the success of the examination. The majority of Centres provided all the materials required and the majority of the candidates experienced no problems when completing the question paper.

Centres are reminded that they should contact CIE if any problems are encountered when supplying the materials or apparatus. To ensure that candidates do not have difficulty in meeting the skills criteria, there should be no changes to either the materials or apparatus without prior consultation with CIE. Any necessary checks on the materials prior to the examination will be included in the Confidential Instructions.

It is important that each candidate receives fresh supplies of materials and apparatus where applicable. Extra supplies of solutions and materials should be made available for any candidate who requests them. It is important that these solutions and materials are labelled only as specified in the Confidential Instructions.

In general, many candidates demonstrated that they had a good understanding of the skills required. There was good discrimination between the weaker and more able candidates and the majority of candidates showed that they were familiar with the use of the microscope.

Candidates who had read the whole of each question before attempting it were more able to plan their time carefully. These candidates could then assess whether they had time to attempt repeats or replicates. For example, candidates should consider the time required to set up and obtain the results and then decide if it

was possible to complete the question and do a set of repeat measurements. In this question paper, it was expected that the candidates would carry out at least two readings per size of block.

Candidates and Supervisors should not be concerned if the results obtained by their candidates are variable, as consistency of results within a Centre is not being assessed.

Comments on Specific Questions

Question 1

(a) (i) Many candidates correctly completed the table showing the measurements and surface areas of two further sizes of blocks which were smaller than block 1.

(ii) The majority of candidates organised their results clearly by presenting a fully ruled table with all the cells drawn, a ruled outer boundary, and appropriately detailed headings for the independent variable (surface area / mm^2) and the dependent variable (time for the iodine to lose its colour / seconds). In addition, many candidates also gained credit for the collection and recording of results as whole seconds and for repeating the experiment and calculating a mean.

Those candidates who are familiar with carrying out investigations presented their results most clearly and gained most credit. The most common errors were to give an incomplete table heading for the surface area or to position the columns incorrectly.

(iii) Many candidates gained credit for suggesting **two** significant errors such as judging when the loss of colour had occurred and the varying temperature of the water bath for each block.

Candidates should be encouraged to read the questions carefully; only **two** errors were required here and any additional errors did not gain any credit.

(iv) The candidates who considered the procedure carefully were able to suggest **three** improvements.

The majority suggested that the independent variable needed blocks with a wider range of surface area. Many candidates suggested that the temperature of the water should be maintained by the use of a thermostatically-controlled water-bath and to use an improved method to cut the blocks more accurately.

Candidates should be encouraged to read the questions carefully; only **three** improvements were required here and any additional improvements did not gain any credit.

(b) (i) The majority of candidates drew the graph, using the headings given in the table, with 'time when bubble released / seconds' on the *x*-axis and 'speed of the bubble / cm s^{-1}' on the *y*-axis.

The better candidates used scales of 2 cm to 5 for time / seconds and 2 cm to 2 for speed of bubble / cm s^{-1}, plotted the points exactly with a small cross or dot in a circle, and drew a sharp, clear line between each pair of points.

The most common errors were omitting the units for both the *x*-axis and *y*-axis, not including a value for the scale on each 2 cm of the axis, plotting points which were just blobs or too large or too small (point not visible when line drawn through it), and drawing lines which were too thick or not ruled. As a general rule, lines should not be extrapolated.

(ii) The better candidates correctly showed on the graph where the reading for 10 seconds had been taken and correctly stated the reading with the appropriate units.

Some candidates gave no indication where the reading had been taken and did not include the appropriate units with the reading.

(iii) Many candidates correctly explained that between 12 and 17 seconds the starch was hydrolysed by the enzyme and that between 25 and 35 seconds most of the starch had been broken down. The better candidates referred to the active site of the enzyme binding to the substrate and forming enzyme-substrate complexes.

Question 2

(a) (i) The better candidates produced drawings made using a sharp pencil to produce clear, sharp lines which joined up neatly, did not include any shading and used most of the space provided without drawing over the text of the question. Many were able to draw the location of the layers of different tissues within the plant section. Within the vascular tissue several regions were observable which the better candidates had viewed by using the higher power of the microscope to identify the different tissues. Some candidates had used the eyepiece graticules to help them draw well-proportioned drawings.

Many candidates gained credit for carefully following the instructions and showing on the diagram the location of the phloem within the vascular bundle.

The most common errors were drawing lines that did not meet up precisely or were too thick, not showing all the different tissues and their correct distribution, which would be observable using the microscope. Some candidates did not include all the layers that were observable within the vascular bundle.

(ii) Those candidates who had experience of drawing as part of their course gained most credit. Credit was awarded to candidates whose drawings were made using a sharp pencil to produce clear, sharp lines which joined up neatly, did not include any shading and used most of the space provided without drawing over the text of the question. Many candidates gained credit for carefully following the instructions and showing on the diagram the location of the lumen.

The most common error was not drawing the cells walls as double lines.

(b) (i) The better candidates showed the measurements for at least three lengths and an equal number of widths of the cells in the cortex, with the appropriate units (mm). The better candidates were able to show the ratio as a larger whole number to a smaller whole number, such as 7:1 or 41:7.

(ii) The better candidates recorded observations using the most appropriate organisation which included one column for listing the features and two additional columns, one headed for cortex and one for xylem. They also correctly decided that observational differences were only those features which they could see in the cortex and the xylem.

Many candidates were able to gain full credit for recording appropriate differences. The most common error was to include functions of the xylem

BIOLOGY

Paper 9700/41
A2 Structured Questions

Key Messages

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In **Section B**, a large number of candidates achieved full marks for **9(a)** but **9(b)** was poorly answered with some very muddled responses showing a lack of understanding about the link between malaria and sickle cell anaemia. Marks for **Question 10** were more evenly distributed between the two sections

Comments on specific questions

Section A

Question 1

(a) Candidates were given a list of events that enable a nerve impulse to cross a cholinergic synapse and were asked to place the events in the correct order. Most were able to do this accurately.

(b) (i) Many candidates correctly pointed out that synapses ensure one-way transmission of nerve impulses because vesicles are only found in the presynaptic neurone and receptors only found on the postsynaptic membrane. The majority of errors on this question were due to the omission of the word *only* or the mixing up of neurone with membrane.

(ii) Few candidates were able to score more than one mark here; usually for mentioning an improvement in memory. Comments about an increased number of nerve pathways or a wider range of responses were uncommon.

Question 2

(a) The majority of candidates were familiar with how penicillin kills non-resistant bacteria. Most recognised that the enzyme was inhibited and that the bacteria would burst. Many went on to correctly describe the inability of the bacteria to form cross-links in the peptidoglycans wall making it weak. Fewer candidates stated that cells were unable resist an increase in internal or turgor pressure.

(b) Candidates who answered this question correctly frequently stated that mRNA is made by transcription, the mRNA was translated and that a polypeptide was produced. Some candidates included further detail of translation and the modification of the polypeptide in producing the efflux pumps. Others mistakenly wrote about genetically engineering bacteria.

(c) (i) Candidates were presented with novel data regarding the resistance of various strains of the bacterium *P.aeroginosa*. Many correctly stated that mutant strain **2** is more resistant because it produces more pumps or more efficient pumps. Fewer were able to give the converse for mutant strain **1** and simply wrote out the figures for MIC of β lactam from the table instead of giving valid reasons for low resistance.

(ii) It was expected that this question would key candidates into describing a fairly generic description of natural selection related to *P.aeroginosa*. Consequently a good answer would indicate that the antibiotic provided the selection pressure and that mutant strain **2** had a selective advantage and was able to survive and reproduce. A significant number of candidates, however, described gene modification and horizontal gene transfer.

Question 3

(a) (i) This question was generally answered very well, with most candidates gaining full marks. Many stated that after the gene was isolated it would be cut to produce sticky ends which would allow it to be inserted into a plasmid which had been cut with the same restriction enzyme. The uptake of the plasmid was a little confused in some candidates with a few referring to restriction enzymes cutting *E.coli*, or the gene being inserted into *E.coli* instead of into the plasmid.

(ii) In contrast, this question was not well understood. Many candidates did not attempt an answer at all and some simply repeated sections of the question. Good answers mentioned that the marker gene would need to be linked to the gene for the wanted protein along with a promoter. The marker gene would need to be expressed to produce the GFP so that the GFP could fluoresce. Many incorrectly stated that it would be the GFP gene or the bacterium itself that would fluoresce.

(b) The majority, including some good candidates, were unsure how to answer this question and some did not attempt it. The idea that only a few molecules of GFP would be produced from a gene, whereas much more would be produced by an enzyme, was rarely mentioned.

Question 4

(a) (i) Most candidates correctly identified **A** as the arrow representing mitosis, although it was often linked with **B**. Other candidates gave a list of letters, indicating that they thought mitosis occurs at many different stages.

(ii) Many candidates demonstrated a good knowledge of the names of the cells at the various stages of spermatogenesis and were able to identify the primary and secondary spermatocytes accurately. Spermatogonia were confused with spermatozoa by a number of candidates.

(b) Good candidates interpreted the micrograph accurately and clearly labelled the three components. Nearly all candidates were able to identify the maturing sperm cell but the germinal epithelial cell and the area where spermatids are found caused difficulties for many.

(c) (i) Many candidates identified that, with increased temperature, there was a reduction in fertility or number of offspring and then went on to link this to the table with correct references to the number of offspring at each temperature. However, a significant number of candidates did not make any references to the data.

(ii) Good candidates stated that increased temperature caused a reduction in fertility or number of offspring in both mutant worms but that the reduction was less in *alg-3*. They then correctly linked this with the data, working out the actual differences in numbers or as a percentage. Some candidates, although understanding what had happened, then simply quoted actual figures directly from the table with no manipulation. Many weaker candidates did not identify the effect of increased temperature and simply stated that the fertility of *alg-3* was lower than *alg-4* at 20°C and that the fertility of *alg-3* was higher than *alg-4* at 25°C.

(iii) The stage of spermatogenesis affected by mutations in both the *alg-3* and *alg-4* genes was correctly identified by the majority of candidates.

(iv) This question was very poorly understood by the vast majority of candidates. Candidates needed to read and understand the text and then apply it to the data and the subsequent question. Commonly, answers only made reference to the failure of the secondary spermatocytes to complete meiosis and linked this with both 20°C and 25°C. The fact that fewer sperm were produced at 25°C only was missed by all but a few and those who did realise this often did not connect it with lack of motility. A few candidates appreciated that the lack of motility was the cause of reduced fertility at 20°C.

Question 5

(a) Most candidates were able to fully explain the meaning of the term self-pollination. The majority were credited for knowing it was within the same plant, although some candidates confused this with being of the same species only. Many were not familiar with the anatomy of a plant and did not name the appropriate organ of reproduction for male and female structures.

(b) The majority of candidates were able to give a minimum of three benefits of cross-pollination such as increased heterozygosity, hybrid vigour and genetic variation. Some gave answers referring to self-pollination, which did not answer the question.

(c) (i) Many candidates were able to describe the trends but a significant proportion of candidates did not read the axes correctly, or make any reference to figures, and this was essential for achieving full marks.

(ii) This question was answered poorly by most candidates. Many correctly stated that it would be better to plant the GM maize far from the wild teosinte but further description of the method needed to employ this was omitted.

Question 6

(a) The definition of an allele as a form, or variant, of a gene was correctly stated by many candidates, although some described it incorrectly as a different type of gene.

Some candidates then struggled to define the term *dominant*, referring to characteristics, rather than alleles, being expressed in the phenotype, or giving imprecise responses such as the allele simply ‘having an effect upon’, or ‘influencing’ the phenotype. Better candidates commented that it would be expressed in either homozygous or heterozygous condition, or that it would always be expressed in the phenotype if present in the genotype.

(b) The vast majority of candidates provided the correct genotype for the heterozygous parents. However, some used different annotations for the alleles despite the fact that they were instructed to use the terms supplied. Others gave monohybrid or sex linked combinations which were not credited. Candidates who had correctly identified the genotypes usually continued to give all four possible gametes, although some combined the alleles of a single gene, such as **BB** or **Aa**. Most candidates then correctly performed the dihybrid cross using a Punnett square. Those who did not use a Punnett square generally made at least one error.

A common error was to not link the genotypes produced with their respective phenotypes, although most candidates who had successfully performed the cross obtained the correct phenotypic ratio and identified the phenotypes.

Question 7

(a) Most recognised that they needed to state basic differences between animals and plants and gave two valid answers such as corals having no cell walls, no large vacuole or that they were heterotrophic.

(b) The term ecosystem was not well answered with many making general comments about organisms reacting within their environment. Only more able candidates made reference to both biotic and abiotic components and the interaction between them.

(c) (i) Most candidates were able to make the correct calculation here.

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Question 8

(a) Most candidates could identify and name the cristae and the matrix from the diagram. A minority got them the wrong way round and a few wrote ‘cisternae’ for cristae.

(b) (i) Candidates needed to state that ATP raised the chemical potential energy of glucose or that it provided activation energy. Many were unable to do this and wrote in terms of activating glucose or lowering its activation energy.

(ii) Most were able to state that NAD removes hydrogen, is a hydrogen carrier or is a coenzyme.

(iii) Correct answers were able to state that either four molecules of ATP are produced from glycolysis from one molecule of glucose or that there was a net gain of two.

(iv) Decarboxylation and dehydrogenation were correctly answered by most candidates.

(v) Matrix was correctly answered by many.

(vi) Many were able to show that the hydrogen released during the link reaction is accepted by NAD and passed to the ETC for oxidative phosphorylation.

(c) Candidates needed to write full answers to score well on this learning outcome. Common omissions were not stating it was found in all organisms, that being small it could easily move around the cell or that it is a link between energy yielding and energy requiring reactions. Most credit was obtained by reference to hydrolysis releasing energy and various examples of the use of ATP, for example active transport. Unfortunately some candidates are still stating that the hydrolysis *produces* energy.

Section B

Question 9

(a) The majority of candidates made a good attempt at answering this question.

Strong candidates made correct descriptions of bivalent and chiasmata formation, and made it clear that the bivalents lined up on the equator and then the chromosomes were separated. Weaker candidates were vague in their description of 'chromosomes' lining up on equator and separating to poles, some referencing that they were split into chromatids. Nearly all candidates mentioned the nuclear envelope reforming and cytokinesis taking place.

Only the better candidates included descriptions of independent assortment and the role of the spindle in separating chromosomes. Some candidates mistakenly described mitosis, so credit was then considerably limited.

(b) Candidates found this question difficult to explain. It was clear that the majority had an understanding of the link between heterozygosity and malarial resistance but the descriptions were not specific enough with respect to the discussion of genotypes.

Some candidates linked the frequency of sickle cell anaemia and malaria by incorrectly stating that malaria is less frequent where sickle cell is high. Most candidates had an understanding that sickle cells cannot carry oxygen very well or that people may die as a result, but did not link this to homozygosity. Very few stated that homozygote normal people had normal haemoglobin or red blood cells or that heterozygotes have sickle cell trait and that their red blood cells are not severely affected. Some made reference to half normal haemoglobin and half sickle cell haemoglobin. Many candidates identified malaria as a parasite that affects red blood cells but some weaker candidates referred to it as a bacterium. Most candidates recognised that malaria is usually lethal.

In this part of the question, little reference was made to selection pressures acting on the respective genotypes and the effect on the frequency of the sickle cell allele in the population. Many candidates discussed there being more sickle cell anaemia sufferers as a result of carriers not getting malaria but did not make reference to both alleles being passed onto offspring maintaining a high proportion of the sickle cell allele.

Question 10

(a) Many candidates were able to identify the primary and secondary pigments and their relationships to one another, in terms of reaction centres and the location on the grana or thylakoids. Many specified light harvesting clusters and reaction centres correctly. Most candidates made references to light capture but only the better candidates referred to light *energy* absorption.

A minority of candidates were able to give the correct wavelengths for light absorption by the various pigments and very few attempted to use diagrams to illustrate the absorption spectra.

(b) Weaker candidates simply referred to auxin as a hormone, while better candidates were able to correctly describe it as a *plant* hormone or growth regulator. Many stated that auxin was merely present rather than produced in the apical buds or meristems. Many were able to show that auxin travels from cell to cell by diffusion or active transport and some mentioned mass flow in the phloem. The effect of auxin on cell elongation was more rarely mentioned; some incorrectly referred to stem elongation. A majority of candidates were able to show that auxin inhibits lateral growth and therefore promotes upward growth of the plant. Here stem elongation was allowed. A few were able to say that other plant growth regulators were involved in apical dominance or interacted with auxin, but hardly any mentioned gibberellins, cytokinins or ABA.

BIOLOGY

Paper 9700/42
A2 Structured Questions

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Section B

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BIOLOGY

Paper 9700/43
A2 Structured Questions

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When using genetic diagrams phenotypes should always be shown linked to genotypes so it is clear which organisms are involved.

Candidates should not refer to energy being *produced*.

General comments

The majority of candidates attempted all parts of the questions in good legible writing. They should be reminded that dark blue or black ink needs to be used as requested in the instructions on the front cover. Candidates made good attempts at the data interpretation questions on the whole. In most cases descriptions of general trends in the data were made, but figures should be carefully chosen to support the statements made, as in 4 **(d) (i)** where not all the values fit the trend. It is also important that candidates note the instructions in the question stem carefully, e.g. in comparative questions such as 7 **(a)** where the response required the advantages of one process compared to another. Giving the disadvantages of only one of the processes does not answer the question. Both free response questions in **Section B** were popular as choices. In both cases part **(b)** proved relatively low scoring compared to part **(a)**. This was especially noticeable in **Question 10** where candidates provided little evidence of factual knowledge in **(b)**.

Comments on specific questions

Section A

Question 1

(a) Most candidates were able to name at least two out of the three structures. Structure **A**, the mitochondrion, was on rare occasions mistaken for a vesicle. Most candidates correctly labelled **C** as either the myelin sheath or a Schwann cell. Structure **B**, the post-synaptic membrane, caused most difficulty as there was often no mention of it being a membrane.

(b) Candidates were required to describe the role of the mitochondrion at the synapse, and most recognised that this is the site of production of ATP. Many candidates made incorrect references to energy being produced. Where credit was awarded for the role of the ATP, many good descriptions were seen, with the role of ATP in the movement of vesicles and in exocytosis being seen most often.

(c) This was the most challenging part of the question but most candidates made a reasonable attempt to provide a response. It was correctly understood that the nicotine would bind to the acetylcholine receptors but many incorrectly thought that this would block action potentials. Good candidates referred to the fact that nicotine would not be broken down (by the normal enzymes present) and therefore action potentials would continue to be generated for a long time.

Question 2

(a) This question discriminated well between candidates of differing ability. Candidates usually described both the cDNA insert and the plasmid as being produced with sticky ends. Time was wasted by a number of candidates in describing the production of the cDNA insert through reverse transcription, which in this case is unnecessary detail. Many candidates referred to the sticky ends being complementary. To gain credit for this they should make it clear that the pairing involves bases. Similarly, when describing the role of DNA ligase sealing the plasmid, reference is needed to the sugar-phosphate backbone. Stronger candidates discussed the formation of hydrogen bonds between the complementary bases or named the phosphodiester bond formed in the backbone.

(b) (i) Candidates who understood the use of antibiotics to select the transformed bacteria scored well on this section. They knew that the bacteria that had taken up the plasmids would survive, while non-transformed bacteria were killed. A large proportion of candidates' responses were too vague, only generalising about antibiotics killing bacteria or they discussed both steps, which was not required. Only the better candidates explained that **step 1** enabled the transformed bacteria to be distinguished from those that had not taken up a plasmid. A few noted that the ampicillin resistance gene was contained in both the original and recombinant plasmids.

(ii) This proved difficult for many candidates. Very few explained that the tetracycline resistance gene was interrupted. Although they realised that the bacteria would not be tetracycline resistant, they needed to refer to the gene no longer functioning to gain credit. Few candidates explained that all the bacteria transferred to plate **T** would have been ampicillin resistant but only the bacteria which could not survive on plate **T** contained the recombinant plasmid. Many candidates incorrectly thought that the importance was that insulin could be made after the recombinant bacteria were identified.

(iii) Many candidates correctly identified the transformed colony, even if they were unable to gain credit for the rest of part **(b)**. Some omitted to answer at all. Some needed to read the question more carefully, as they were required to circle an existing colony on plate **A** instead of a non-existent colony on plate **T**.

(c) (i) Most candidates correctly described the increase in antibiotic-resistant bacteria, the necessity for new antibiotics to be made or a reduction in the effectiveness of current antibiotics. To gain full credit a reference was needed to the transfer of plasmids. Good responses also described plasmid transfer between bacteria of either the same species or different species.

(ii) A few candidates described the use of the gene for β-galactosidase and its detection by a blue colour on X-gal medium. Most made reference to detecting fluorescence but rarely was the type of gene described correctly. Since the gene itself is not fluorescent it should be described as a gene producing a fluorescent product.

Question 3

(a) This was answered well by most candidates who realised that PBP was an enzyme and therefore a protein. Most described the globular and tertiary structure or referred to the presence of an active site.

(b) Although most responses gained credit for suggesting that it was still possible to make the cell wall, further explanation was required for full credit. A large number of candidates incorrectly described penicillin as being completely unable to bind with PBP2a. Candidates needed to suggest that if penicillin only rarely binds then most PBP2a molecules are not blocked and as a result the wall still forms.

(c) The majority of answers referred correctly to the lack of a cell wall. A few other correct alternatives were seen, such as the lack of glycoprotein peptidase or that viruses have no cell structure.

Question 4

(a) Many candidates labelled the diagram successfully, although a few candidates confused the endosperm with the embryo. Most problems arose over the labelling of **B** where candidates need to clearly label the outer (clear pink) layer pointing to the pericarp, rather than the aleurone layer.

(b) An explanation was required in this section rather than a simple description. Candidates described the relative amounts of protein, fibre and carbohydrate in the two types of grain but did not always explain clearly what had caused the difference. The higher protein content in the whole grain flour needed to be related to the presence of the aleurone layer, while the dietary fibre needed to be linked separately to the presence of the pericarp to gain full credit. Further credit could be gained by explaining the reduction of a particular constituent being due to the removal of a named part of the grain during the production of white flour.

(c) (i) Only a few candidates suggested that starch has to be broken down first before absorption could occur or that the digestion would take time. The essential understanding required here is that the glycaemic index is a measure of the speed with which the food increases blood glucose concentration. This in turn depends on whether the food can be absorbed directly into the blood.

(ii) Although a number of responses referred correctly to the difference in the bonds present, few candidates related the lower GI to the speed of breakdown of the molecules. There were many correct references to the branching of amylopectin but these needed to be linked to there being more sites (ends) on which enzymes could work.

(d) (i) The majority of candidates were able to describe the relationship between whole cereal grain intake and risk of diabetes and noticed that not all the values fit the trend. Figures were usually quoted to support these ideas.

(ii) Despite being asked to relate the answer to the results of the study as shown in Table 4.2 many candidates commented incorrectly on possible differences between the women. Reasons why the data could not be used needed to relate to how the comparisons were made between the two types of grain. Correct explanations concentrated on how this study was carried out, noting that the intervals of serving size used were not the same and therefore not comparable. Other possibilities were that the serving sizes were unknown and that the base risk of 1.00 was not the same for each group.

(iii) Most candidates noted that fruits contain sugars but it was rare for further credit to be gained for referring to sugar having a high GI.

Question 5

(a) The majority of candidates gained full credit by referring to sperm being added to oocytes in a suitable dish. A number of candidates did not use the term oocyte and were unable to gain credit. It has been noted in many previous reports that the terms egg and ova are not suitable in this context.

(b) This proved difficult for many candidates. The better chance of survival and a better chance of implantation were possible advantages. Disadvantages could be the difficulty of keeping the embryo alive for this length of time or that implantation might be less likely. As a 'suggest' question candidates were able to refer to implantation in terms of an advantage or disadvantage for partial credit.

(c) (i) Good candidates stated that single top-quality embryos gave the highest success rate of all three methods, with supporting figures quoted. A few candidates did gain further credit by noting that there was little difference in the success of single top-quality embryos and multiple embryo transfers or by noting the increase in risk resulting from multiple embryos during pregnancy or birth.

Many calculated the percentages of pregnancies resulting from the different embryo transfers. These figures needed to be calculated to one decimal place and not rounded up to whole numbers. Single top-quality transfers were usually stated as having a higher chance of a successful pregnancy than the single, non-selected embryos, but a comparison with multiple embryos transfers was also needed. This may have been omitted if the figures were rounded up, which appeared to remove any difference between single top-quality embryos and multiple embryo transfers.

(ii) Candidates usually gained credit for reference to some embryos having to be discarded. Many references were seen to religious objections or designer babies that did not gain credit. To gain credit these ideas needed expanding to refer to the possibility of embryos being selected only if they have features desired by parents or society.

Question 6

Where candidates were familiar with the concept of multiple alleles they gained maximum credit with little difficulty. Candidates needed to understand that dominance can only exist in relation to another allele. In this case, where fur colour is controlled by multiple alleles, a particular allele can be dominant to another allele at the same time as being recessive to a different allele. It is necessary to state which allele is dominant to which, not just to state "yellow is dominant". While credit could be gained from explaining the crosses diagrammatically, this was only possible if phenotypes were shown linked to genotypes so that it was obvious to which mice the diagrams were referring.

(a) (i) Good candidates recognised that the agouti allele was dominant over the black allele and that the agouti parents could be either heterozygous or homozygous. Further credit was available for a reference to the black parent being homozygous recessive.

(ii) The yellow allele being dominant to the black allele was noted by many candidates. A few also realised that being homozygous for the yellow allele was lethal, so mice with this genotype do not survive. Many candidates showed a 3:1 ratio in a diagram but it was also necessary to show which of the genotypes produced the 2:1 ratio to gain full credit.

(iii) It was expected that candidates would describe the yellow allele as being dominant over the other three alleles but many referred to it being 'most dominant' or the black allele being 'most recessive' incorrectly implying degrees of dominance. The other important feature to note here was the fact that the yellow mice were always heterozygous, enabling the other phenotypes to occur in the offspring.

(b) The majority of responses successfully described a test cross with a black mouse and its possible outcomes.

Question 7

(a) Many good responses were seen with the advantages of cross-pollination described well. A significant number of candidates only described the disadvantages of self-pollination, so were unable to gain credit.

(b) (i) Although several lines were allowed for the answer, many responses only named the crop that was most or least affected by the decline in honeybees with no explanation. The almond only being pollinated by the honeybee was a suitable explanation of why they were most affected. Since there were several pollinators involved for the other crops, it was expected that the lowest proportion of flowers being pollinated by honeybees would be calculated to justify the orange being least affected.

(ii) Candidates were usually able to refer to food shortages, increased temperatures or disease as possibilities here. Many also referred to pesticides or predators but this required the idea of an increase in use or numbers to gain credit. Pollution references were generally too vague with some qualification, such as a named pollutant, being needed.

Question 8

(a) (i) The majority of candidates correctly named the cytoplasm.

(ii) Candidates usually noted that anaerobic respiration is required to maintain some production of ATP in the absence of oxygen. They understood that only glycolysis occurs and that this requires the regeneration of NAD to allow glycolysis to continue.

(iii) Most were able to correctly name the enzyme. Care must be taken with spelling as references to lactose or lactase did not gain credit.

(iv) Both the type of reaction and the bonds formed were usually well known, although weaker candidates described the reaction as glycogenesis so could not gain credit for the type of reaction.

(b) In general, candidates gave very good descriptions of the anaerobic respiration pathway in yeast cells and this section proved to be high-scoring. Most candidates named the two compounds in the two-step pathway, named the dehydrogenase enzyme and understood that the ethanol pathway is not reversible. Extended answers also noted that carbon dioxide is removed from pyruvate. Although only the strongest candidates discussed the loss of potential energy through generation of ethanol, as it cannot be used by the yeast cells, where this appeared in answers candidates had usually already scored maximum credit.

(c) (i) Most candidates understood that the respiratory quotient was the relationship between the carbon dioxide produced and oxygen used. For full credit, candidates needed to refer to how the gases were measured, either by volume or number of moles rather than vague terms such as "amount". Some candidates displayed a lack of understanding by discussing the use of carbon dioxide and production of oxygen.

(ii) Many candidates were able to correctly quote these figures.

(iii) If candidates understood how to calculate the RQ, they generally knew that dividing by zero (as no oxygen is present in anaerobic respiration) gives an infinite value. Credit was only given if the RQ value becomes comparatively higher (i.e. RQ value increases), rather than just high.

Section B

Question 9

(a) Given that crossing over and independent assortment are key features of meiosis, this question did not generally score particularly well. There were frequent omissions in descriptions and diagrams in support could only be given credit with sufficient labelling. Candidates needed to make it clear that the events occurred at prophase in meiosis I. In describing crossing over, the precise structures involved should be described i.e. between non-sister chromatids of a pair of homologous chromosomes (i.e. chromosomes plural). The formation of chiasmata was usually mentioned but candidates often referred to genes being exchanged, instead of genetic material, alleles or sections of chromatids.

In describing independent assortment relatively few candidates made it clear that this involved pairs of homologous chromosomes or bivalents, rather than individual homologous chromosomes. Most responses did describe the chromosomes lining up independently at the equator, but a re-wording of the statement 'independent assortment' into 'assorted independently' was insufficient to gain credit. A significant number of candidates incorrectly included descriptions of anaphase or referred to metaphase II. Few candidates referred to the unique genetic make-up of the gametes produced, with many referring only to daughter cells rather than to gametes.

(b) Most candidates answered by describing artificial selection but found it difficult to compare this with natural selection as they needed to have a good understanding of the basic principles involved. While most realised that the selection was carried out by humans, this was usually followed by a description of an example. This could only gain credit if it was made clear that the feature was being selected for human benefit rather than the organism's benefit. Correct references were seen to artificial selection causing lower genetic diversity, increased homozygosity and loss of vigour. In natural selection a number of candidates referred to it promoting survival, with a few noting that isolating mechanisms would be involved. It was rare for candidates to include a reference to inbreeding versus outbreeding or the relative speed of the process.

Question 10

(a) Many excellent responses were seen, with candidates describing the process of photolysis in detail, most providing a correctly balanced equation. The role of protons in the formation of reduced NADP was well known and their subsequent role in the light independent stage. Electrons were also described correctly as being involved in the reduction of NADP, the electron transport chain and the restabilising of P1. Although most candidates stated that oxygen was a product, few

attempted to describe what happened to it, neither its use in respiration nor its release from the plant through stomata.

(b) The better responses described gibberellins as plant growth regulators and how plants were able to grow tall by their stimulating effect on cell division and cell elongation. A small number of excellent descriptions referred to the active and inactive forms of gibberellins. Few correctly related the different forms to the presence of dominant or recessive alleles. A significant number of candidates concentrated on the role of gibberellins in seed germination, which was not relevant to this question.

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Planning, Analysis and Evaluation

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General comments

There were some well written answers showing a good understanding of the expectations of the paper. At the other end of the spectrum there were answers that did not address the question, in particular drawing conclusions in **Question 1(c) (i)** and the use of statistics in **Question 2(c)**. It is important that candidates read all the information provided carefully and use it in answering the questions.

There was no evidence of lack of time and the vast majority of candidates attempted all the sections of both questions.

Comments on specific questions

Question 1

This question was intended to assess candidate's ability to identify different variables and to describe how to make a serial dilution. Candidates were also expected to draw conclusions from complex data and suggest ways of modifying an experiment to improve the results.

(a) (i) Most candidates gained credit here. Poorer answers did not actually identify the dependent variable being measured, but gave the vague answer of 'growth'. It is important that candidates realise that the dependent variable is the factor measured directly. In this case it is number of thalli.

(ii) The most common correct responses were time, temperature and number of plants. Poorer answers often included nitrate concentration, suggesting some confusion with the independent variable. A small number of candidates referred to the sterilisation of the plants, but did not appreciate that the variable being controlled was the activity of microorganisms.

(iii) There were a number of variables that should have been standardised. Most candidates were able to suggest two. The most common answers were pH, volume of nitrate concentration, light intensity and size of thalli. Many candidates stated 'amount of nitrate solution' which was not credited unless an actual volume was given. Only better answers described a suitable method of standardising the variable such as using a pipette for measuring a volume. Poorer answers were too vague, for example, 'light is kept the same' or 'keep the same volume', or used unsuitable equipment such as a metre ruler to measure 5 mm. A surprising number also gave temperature, which was one of the variables already standardised.

(b) (i) Few candidates were able to give a clear description of how to make a serial dilution. Some better answers used a diagram to explain the procedure or a table showing how to make the dilutions. Poorer answers showed considerable confusion between serial dilution and proportional dilution, candidates often stating that they were making a serial dilution, but quoting volumes that were incorrect ratios. The current syllabus has a section explaining the difference (*Syllabus for June and November 2014)*. The formula $c_1v_1 = c_2v_2$ was also commonly quoted, often with a long explanation about how to use the formula, but without actually making any solutions. The values given in the question showed that the concentration halved at each dilution, so candidate were expected to describe the standard process of taking a known volume from each consecutive solution and diluting with an equal volume of pond water. Credit was not given unless the complete sequence was described. Only the best answers mentioned that solutions should be stirred in order to ensure homogeneity. Almost all candidates used distilled water, although the information clearly stated that sterile pond water was used. There were many answers that showed careless use of the units used for concentration and volume, for example, adding 10 mg/dm^3 of water to make a dilution. Candidates need to be accurate in the use of units.

(ii) The majority of answers did not show an understanding of the purpose of a control. The plants were in sterile pond water to which sodium nitrate solution was added, so the control also needed to contain the pond water otherwise any differences could be due the absence of pond water. The majority of answers stated distilled water.

(c) (i) Answers to this question varied greatly. Better answers gave the expected meaning of standard deviation, although sometimes linked this to accuracy rather than reliability. Poorer answers appeared to miss the point of the question and described the changes in the standard deviation with time.

(ii) Relatively few candidates appeared to understand why standard deviation increased with time. This suggests that candidates did not recognise that the standard deviation was calculated from counts from four populations. Thus, as the number of plants increased, there would be increasing variability between the different populations, increasing the spread.

(d) The answers to this part of the question illustrated clearly the need for candidates to be familiar with the analysis of data from experiments. Only a few better answers referred to the control, showing that candidates often do not seem to understand the purpose of a control. In this experiment it is not possible to draw valid conclusions about the effect of additional nitrate unless there is a base line for comparison. Consequently, answers that just said 'nitrate increased the number of thalli' were not credited. Many candidates recognised that there was an increase in the number thalli up to a concentration of 1000 mg dm^{-3}, but then stated that this was the optimum concentration. Only the best candidates realised that the optimum must lie between 500 – 2000 mg dm^{-3}. Candidates who noticed that the number of thalli started to decrease above a concentration of 2000 mg dm^{-3} often failed to gain credit as they did not make it clear that this was relative decrease. The number of thalli was still higher than that at 500 mg dm^{-3}. A minority of better answers explained the reason for this fall in number, either in the context of osmosis or nitrate inhibition.

Poorer answers tended to describe the change in number of thalli over time, although the question specifies the effect of nitrate concentration. The weakest answers were little more than a description of data. Candidates should understand that just stating data is not drawing a conclusion. A conclusion should comment on the trends observed and then data can then be used to support the conclusion if appropriate.

(e) Many answers were imprecise. Candidates often referred to a greater range which implies using values above 4000 mg dm^{-3}, rather than smaller intervals between concentrations within a narrower range. If candidates stated 'use a greater range of concentrations' between a range that included values above and below 1000 mg dm^{-3}, then credit was allowed. It is important that candidates appreciate the difference between range and intervals when considering a series of values.

(f) Many candidates gave a correct answer. The most common error was label the *x*-axis as number of thalli, but to then draw a line through the origin, would imply no cells at the start. With other suitable labels such as growth, the plot could start at zero or above. Poorer answers reversed the axes.

Question 2

This question was intended to assess the ability of candidates to calculate changes in populations of bacteria, to use statistics to determine the significance of any differences in the populations and to evaluate data.

(a) (i) The answers to this question showed which candidates had experience of estimating the number of bacteria in a population. Better answers made reference to using a grid or haemocytometer and counting the number of bacteria in a fixed volume. Candidates commonly mentioned obtaining a sample, but did not specify a suitable volume. Many candidates did not appear to have any concept of the volume that can be placed on a slide, for example 10 cm^3 was a common answer. Although some candidates referred to using a grid, this was often used to measure an area which was then assumed to be the equivalent of a volume. The majority of candidates described an inappropriate method, commonly using a graticule to measure the diameter of the field of view, calculating the area and then counting bacteria in this area. Other candidates suggested working out the volume or area or weight of a single cell and then multiplying this by the total volume or mass of the fermenter. Although candidates commonly referred to using a microscope, only better answers gave a suitable magnification. Many candidates suggested that bacteria can be counted at low power.

(b) Answers to this question were very variable. Better answers described the calculation correctly, or gave a formula. Poorer answers suggested that candidates had not read the question carefully and described how to calculate percentage increase. Other candidates subtracted the number of stained cells from the total cells, which would give the percentage of dead cells. A great many candidates gave examples of stains that might be used to identify living cells, such as methylene blue, radioactive and fluorescent stains. These candidates then often tried to measure area of stained cells and total area to find the number of cells.

(c) Overall this section was poorly answered. There were candidates who showed a good understanding of statistics and gained maximum credit. Others who had relevant knowledge missed out because of careless use of terminology.

(i) Only better answers gave a clear statement that referred to the two culture systems. Poorer answers were often too general, for example ‘there is no difference between the observed and expected results’. The majority of answers were not suitable. Common incorrect hypotheses were ‘the perfusion system is better than the batch culture system’ and ‘there is a 0.5 probability that it will be significant’.

(ii) Many candidates were able to give the correct number of degrees of freedom. The most common incorrect answer was 19, suggesting that candidates had calculated for only one fermenter system. In poor answers, candidates appeared to be guessing.

(iii) Candidates who gained credit for parts **(i)** and **(ii)** usually gave a correct answer here as well. Poorer answer often contradicted themselves, for example, ‘it is significant and due to chance’.

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Paper 9700/52

Planning, Analysis and Evaluation

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Paper 9700/53

Planning, Analysis and Evaluation

Key Messages

In this paper it is important that candidates read all the information provided carefully and use it in answering the questions. Candidates need to apply principles from practical work to the questions in the paper which may be on less familiar areas of the syllabus.

Candidates should have experience of analysing complex data so that they can draw conclusions and evaluate evidence that are consistent with the data. Conclusions require candidates to recognise overall trends in data and make informed comments about these trends. Candidates should also be aware that conclusions should include detailed scientific explanations as appropriate. Evaluation requires candidates to consider the design of an experiment in terms of how well it tests the independent variable and to make decisions about the reliability of data.

General Comments

There were many good responses showing that candidates had understood the principles involved. There was no evidence that the candidates were short of time.

Comments on Specific Questions

Question 1

This question covered all the skills involved in the paper.

(a) (i) Most candidates identified the nitrate concentration as the independent variable. There was more confusion over the dependent variable. It is important that candidates realise that the dependent variable is the factor measured directly. In this case it is number of cells. So answers such as 'growth of population' did not gain credit.

(ii) Many candidates scored this mark. Volume of growth medium and of culture were often given and credited. There were still some responses where 'amount' was stated. This was not allowed unless qualified by the actual volume. A few answers incorrectly suggested volume of sodium nitrate or just stated volume of sample unqualified. The information in the question suggested that the flasks were placed 'in sunlight at room temperature'. Some responses suggested one or both of these as examples; this was allowed in the context of the question, but if they were given here they could not then gain credit in **(a)(iii)**.

(iii) There were a range of possible answers here which gained credit. Some answers identified a variable to control but did not then give sufficient detail of how it would be controlled. An example of this was identifying that the volume of sodium nitrate to be added should be controlled, but then not indicating that something like a graduated pipette would be used to measure the volume. Temperature and light were often given which was very appropriate here provided they had not been mentioned in **(a)(ii).** With regard to temperature control, some answers were too vague. For example 'thermostatically controlled water bath' not just 'water bath', or 'temperature controlled room', not just 'air conditioned room' was needed. Controlling the pH with a buffer was the correct response most commonly seen. Some candidates correctly suggested that oxygen and/or carbon dioxide concentrations should be controlled. The methods of control were less well covered in terms of a suitable method to supply the stated gas. There were cases where candidates had not read the information in the question carefully and thus gave variables that had been controlled such as the volume of culture sample. Some responses suggested that the volume of the sample put on

the haemocytometer needed to be controlled. This is not necessary as the sample is standardised by reading a fixed haemocytometer grid.

(b) (i) Many answers showed a facility with the mathematics involved and also showed that the information had been read carefully, allowing the candidates to gain full credit. Assuming 1 dm^3 is being made up, 2.125 g of sodium nitrate would need to be weighed out and dissolved in water. Good answers gave this information or equivalent weights to make up different volumes and used deionised water not just 'water'. Weights given in this type of answer should not be expressed to more decimal places than is possible on a standard laboratory balance.

Some candidates assumed that the 25 mmol dm^{-3} had been provided and so missed out this stage in their account. Others described a method for making up each different concentration by weighing different masses of the nitrate. Both of these points underline the importance of reading the question material carefully.

To prepare the given concentrations from the starting solution is not a serial dilution but a proportional one. Many candidates were able to give the proportions of 25 mmol dm^{-3} sodium nitrate to water needed to produce the stated concentrations and even suggested all should be mixed thoroughly. Some carried out the correct method even though it was called a serial dilution, and gained credit. A small proportion actually did an inappropriate serial dilution for which there was no credit.

(ii) This was not well answered, with most candidates suggesting only water. The sodium nitrate would be replaced by water (of the same volume), but the growth medium must still be present or otherwise any differences could be due to lack of the growth medium or the lack of nitrate.

(c) (i) This was well answered in terms of finding the difference between the new and the original samples and then dividing by the original and multiplying by 100. This was often put as a formula. Fewer candidates appreciated that five samples were taken at each time and thus dividing by the number of samples would give the mean.

(ii) There was good understanding here in terms of the problem of different starting numbers and ease of comparison between the samples. Less good responses which did not gain credit included vague ideas about being 'more accurate' or 'more reliable' and reference to removing anomalies.

(d) Many candidates seemed to have looked at the data carefully to spot patterns. Accuracy of expression sometimes meant that full credit was not gained. Candidates should remember that just stating data is not drawing a conclusion; that requires making a statement about the trends observed. Stating data can then be used to support the conclusion if appropriate. The question asked for conclusions regarding the different concentrations of nitrate on the growth of the culture. Therefore answers should focus on the growth at the different concentration, not on the changes over time at any given concentration. Most candidates noted that the growth increased up to concentrations of 15 mmol dm^{-3}, but some confusion was seen in the conclusions for higher nitrate concentrations. The number of cells does not drop – the percentage increase in numbers decreases. Many candidates suggested that 15 mmol dm^{-3} was the optimum concentration. This cannot be concluded from the data – all that can be said is that the optimum will lie between 10 and 20 mmol dm^{-3}. A general conclusion that can be made is that compared to the control all concentrations increase the growth. Some candidates extended the conclusions to suggest how the nitrate might increase growth via protein synthesis, or, at high levels, might inhibit growth. This gained credit.

(e) Using smaller concentration intervals either side of 15 mmol dm^{-3} was the expected answer. The key idea is the smaller intervals but given the data it would be unnecessary to go outside the range 10 – 20 mmol dm^{-3}. Candidates were not penalised if they used smaller intervals across the whole range. Some candidates suggested smaller intervals between 15 and 20 mmol dm^{-3} for which there was no credit as the optimum could lie either side of 15 mmol dm^{-3}. Several candidates suggested using a wider range of concentrations which implies using values above 25 mmol dm^{-3}. In some cases the explanation of this made it clear that they would use the smaller concentration intervals within the range. It is important that candidates appreciate the difference between range and intervals when considering a series of values.

(f) This was generally well done. A few candidates inverted the axes with phosphate on the *y*-axis. If the number of cells was used as the *y*-axis label, then the plot line could not start at zero as this would imply no cells at the start. With other suitable labels such as growth or % increase, the plot could start at zero or above.

Question 2

After a section testing the candidates on experimental method, the rest of the question concentrated on data handling and evaluation. A large amount of information was provided on the paper as the context was a relatively unfamiliar one. It is important that this is read carefully before answering the questions.

(a) There were some good answers clearly indicating that the fluid after dialysis would be tested with the strips and that a colour indicating urea would show the treatment to be effective. This colour change could be to darker or measured by comparison to a standard. Another possible way would be to test the blood both before and after dialysis. Many of the answers however were very confused. A number of candidates suggested testing urine. With kidney failure little or no urine would be produced – but if a little was being produced then testing before and after dialysis would be needed. There was also a tendency to confuse urea and urine. Many answers did not specify what was being tested at all. There was also a tendency to simply quote the question and say that a change of colour in the strip indicated the urea concentration without developing this to answer the question with regard to the effectiveness of the treatment.

(b) (i) Many candidates were confused here and thought that S_M was standard deviation rather than standard error and thus talked about the spread around the mean. Standard error shows how close the sample mean is to the population mean, thus measuring the reliability (not the accuracy or validity) on the estimated mean. The larger the standard error, the less reliable the estimate.

(ii) This section was frequently well answered. Candidates were aware the data was continuous or that means were being compared.

(iii) The stem of the question indicates that test **A** was used as a comparison for the other tests. The important thing which indicates that the *t*-tests might be significant is that most of the standard error values in tests **B** and **C** do not overlap with those in test **A.** Very few candidates appreciated this and some thought none overlapped which is not so as **A** and **B** for ferritin do overlap.

(c) (i) Unlike **Question 1 (d)** where the candidates were asked to state conclusions, here the question asks for evidence for an already stated conclusion. All three iron containing substances increase more when provided by injection compared to provision by mouth and two of them (haemoglobin and iron) reach the range found in non-anaemic people. Good answers gave these points and backed them up by appropriate data quotes. Weaker responses sometimes gave data quotes without indicating which substance was being discussed.

(ii) The small sample size with a limited age range and a gender bias towards men were all limitations seen and credited in many scripts. However a number of candidates did not use the information provided and listed variables that needed to be considered when selecting participants like diet and general health whilst others discussed the advantages and disadvantages of administration by injection.